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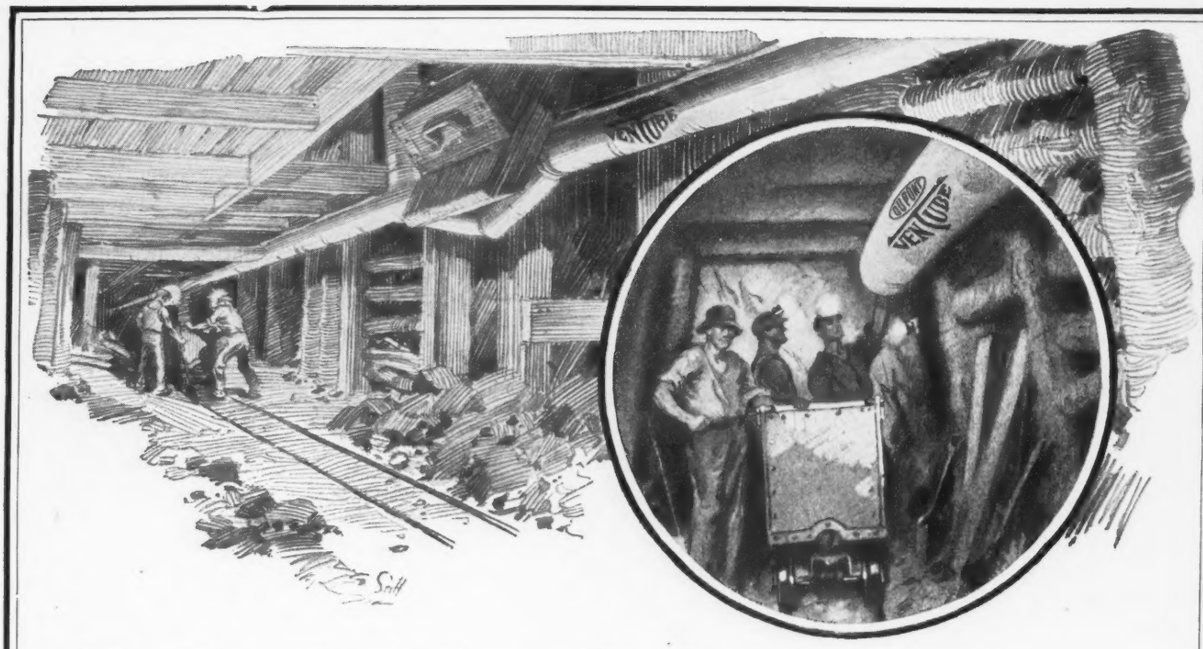
REMAINS OF THRESHING OUTFIT AFTER DUST EXPLOSION AND FIRE

MARCH, 1923

VOL. III MASSACHUSETTS INSTITUTE OF TECHNOLOGY NO. 9



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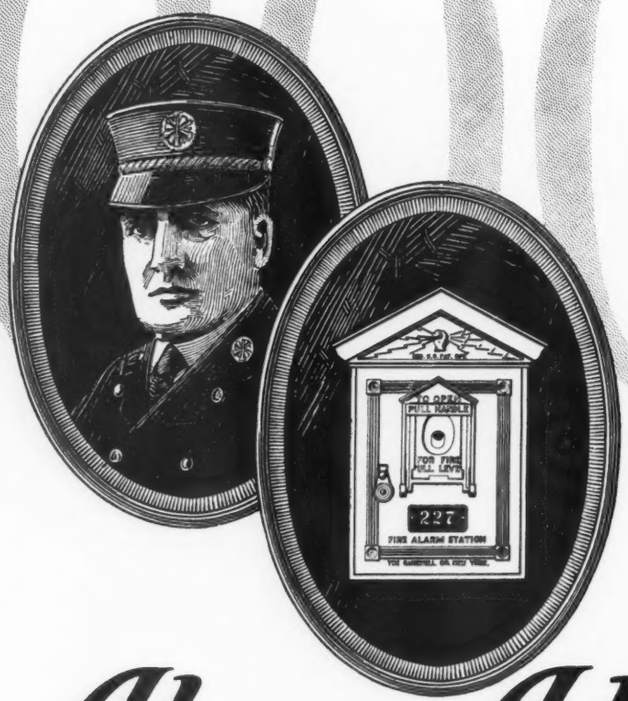

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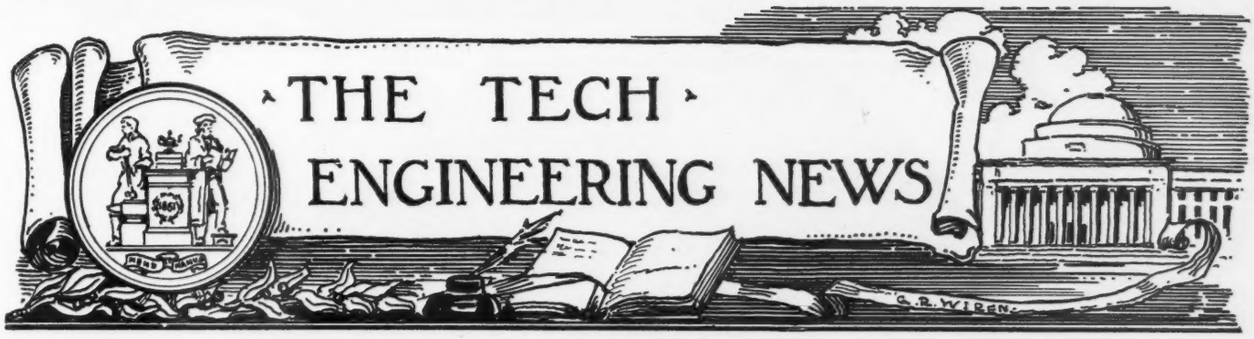

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TABLE OF CONTENTS

	Page
THE DE-INKING OF OLD NEWSPAPERS.	273
THE MINING, GEOLOGICAL, AND METALLURGICAL LABORATORIES OF THE INSTITUTE. By Prof. Charles E. Locke, '96	274
HOW TO SUCCEED IN BUSINESS. By Charles M. Schwab	276
THE ELECTRICAL ENGINEERING LABORATORIES OF TECHNOLOGY. By Prof. F. A. Laws, '89.	277
THE GROWTH OF RESEARCH IN AN INDUSTRY. By Francis E. Cady, '01.	278
STATIC ELECTRICITY AS A CAUSE OF DUST EXPLOSIONS. By Prof. F. A. Rogers and Dr. Harold H. Brown.	279
HYDRAULIC WAVE TRANSMISSION OF POWER. By Major F. Johnstone-Taylor.	284

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THE TECH ENGINEERING NEWS

THE PROFESSIONAL JOURNAL OF THE ALUMNI AND UNDERGRADUATES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

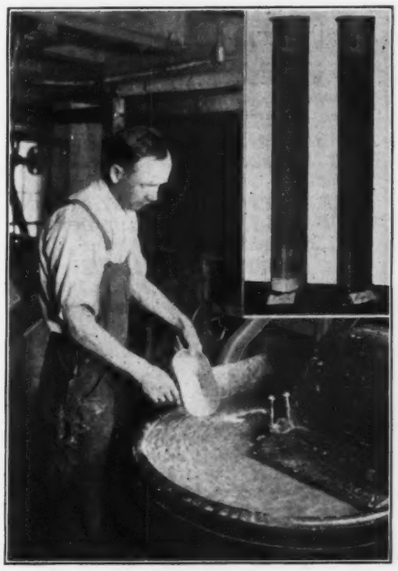
VOLUME III MARCH, 1923 NUMBER 9

THE DE-INKING OF OLD NEWSPAPERS

It is estimated that if the cutting of our forests at the present rate were to continue, it would only be a question of half a century when our supply of timber would be gone. The production of modern newsprint is dependent mostly upon the forest for its raw material. Approximately seven thousand tons of newsprint are used daily in the United States. A survey of the waste paper field indicates that in our large metropolitan centers about two thousand five hundred tons of this per day could be collected. In terms of forest acreage this means, roughly, the saving of the cut each year on about two hundred and seventy-five thousand acres. This acreage carries a crop not produced in a year, but a spruce forest requiring one hundred years or longer to grow. It will at once be seen that the de-inking of old newspapers is desirable, and will represent a considerable saving in our natural resources.

There is another economic consideration which makes de-inking desirable. The present supply of newsprint, coming largely from mills in the Northeast and Lake States, is derived from forests in the United States now seriously depleted, or from less accessible forests in Canada. These latter now furnish sixty-five per cent of the raw pulp used by mills in this country. Many of these mills, representing immense investments, no longer have a raw supply of their own, but are dependent either on a foreign supply of pulp or of pulpwood that must be hauled long distances into the United States. The increasing distances to the fast-receding forests mean added freight and a higher-priced product. Also, the mill operating on imported pulp is always under the shadow of the possibility of an embargo, even now far from a theoretical menace.

The use of old paper stock for the manufacture of paper is very old, and we find mention of a process by George Balthasar Illy in Denmark as early as 1695. In 1775 Professor Klaproth of the University of Gottingen suggested the use of turpentine and clay for the purpose. In 1794, during the French Revolution, Citizen Masson, a woman, ran an establishment for the



PUTTING POWDERED BENTONITE INTO BEATER FULL OF NEWSPAPERS

The bentonite attracts and carries off the particles of ink carbon which have been separated from the fibres by a mild alkali. Insert shows the extraordinary suspension qualities of bentonite (tube 2) as compared with English china clay.

conversion of old papers into new. In 1801 Matthias Koops established the Neckinger Mill at Bermondsey, England, to de-ink printed papers and make new papers therefrom, using dilute alkali to dissolve the varnish in the ink, clay to act as a carrier, and washing to remove the carbon black. Bleaching with chlorine followed to brighten the stock. Henry E. Rogers is the first person mentioned to use old newspapers in the manufacture of paper in the United States in a mill in Connecticut, in 1849. During the last fifteen years, however, interest in the subject seems to have been unusually active, and a great number of patents have been taken out, suggesting the use of alkalies, soap, margaric acid and oleic acid in conjunction with alkalies, whiting, clay, talc, ground soapstone and earthy matter.

In general, these processes consist of the solution of the varnish with some alkaline compound such as caustic soda, soda ash, or sodium soaps to liberate the carbon black and the holding of particles of carbon black in colloidal suspension by preventing agglomeration with the use of peptizing agents such as soaps, silicic acid, aluminum hydroxide, vegetable jellies and clay, talc, and whiting, containing traces or small quantities of colloidal matter. In the case of clays and talc, the value they possess as a protective colloid is due to the fact that their smallest particles are peptized by the alkalies, especially if digested at high temperatures. Only papers free from groundwood can withstand the alkalinity and temperatures commonly used. It is well known that groundwood cannot withstand such treatment without discoloration, and attempts to completely de-ink newspapers have, as a rule, not met with success.

Early in 1921 the Forest Products Laboratory undertook a series of comparative tests at the expense of the Paper De-Inking Company, to determine the efficiency of a process patented by them which proposed using bentonite as the peptizing agent, or protective colloid in conjunction with alkalies, in comparison with other methods proposed. The result of the work showed such marked improvements in the process by the use of bentonite, especially when allied to newsprint, that it seemed desirable to publish them and discuss, so far as possible, the principles involved.

(Continued on page 298)

THE MINING, GEOLOGICAL, AND METALLURGICAL LABORATORIES OF THE INSTITUTE

By Prof. CHARLES E. LOCKE, '96

Associate Professor of Mining Engineering and Ore Dressing, Massachusetts Institute of Technology

We find in the scope and plan of the Institute, written by President Rogers in 1864, that laboratories in mining, metallurgy and geology were comprised in his scheme of scientific education, and in the first catalog issued in the year 1865–66, mention is made of a laboratory of metallurgy, mine models, mining and metallurgical machines and geological collections. At that date, however, these existed apparently only on paper, or largely in the mind of President Rogers.

The first apparatus was a crucible furnace and a muffle furnace, both for fire assaying. The exact date of their purchase is not recorded, but it must have been prior to 1868, as the first class of the Institute, which graduated in that year, received practical instruction in fire assaying. In 1868–69 we find a record of something tangible in the form of the valuable geological collection of Professor Henry D. Rogers, which had been presented to the Institute. The next year a set of Freiberg models was secured. These are described as actual working models which illustrated mining work and the operation of mining machines. Incidentally, it may be noted that some of these models still survive in the department as curiosities, having largely outlived their usefulness.

Professor Richards, who had laboratory instruction as part of his duties after his graduation in 1868, was not satisfied with the miniature models which served only to illustrate principles. He foresaw the need of practical machines which could be operated and adjusted so as to actually perform real work on a reduced scale. The trip of President Runkle across the continent to California in 1870, during which he visited mines and manufacturers of mining machinery, was the means of indicating what processes could best be illustrated in the laboratory, and what apparatus was obtainable. Real coöperation was secured in the form of helpful advice from the mining men, and substantial price concessions from the manufacturers.

In 1871, Professor Richards went on the summer school trip to Colorado which furnished further opportunity to crystallize ideas, with the result that in the President's Report of 1871–72 the following list of apparatus is given as either installed or in process of construction: three by five inch Blake crusher, twelve-inch Whelpley and Storer dry pulverizer, five-stamp battery amalgamating pan, settler, concentrator, reverberatory roasting furnace, crucible furnace, assay muffle furnace, reverberatory smelting furnace, blast furnace and cupelling furnace. The credit for the installation of these first furnaces belongs to Professor Ordway. In 1873 a hydraulic classifier, a jig, and a Rittinger table were added, so that by 1874 the ore dressing and metallurgical laboratories were in full operation.

The old cut which is here reproduced pictures to the reader the small beginning. These original laboratories in the Rogers basement occupied a space of 1976 square feet, of which 1118 square feet was allotted to the ore-dressing laboratory, and 858 square feet to metallurgy. They grew slowly, year by year, until they finally spread over practically the entire basement of Rogers Building. The present quarters in Cambridge include, for laboratories alone, nearly 25,000 square feet, divided as follows: fire metallurgy, 4480 square feet; department shop, 752 square feet; mining laboratory, 1155 square feet; crushing and sampling, 1104 square feet; ore dressing, 8462 square feet; wet metallurgy, 1494 square feet; fire assaying, 3601 square feet; wet assaying, 1787 square feet; weighing room, 444 square feet; five research laboratories, 1543 square feet; total, 24,822 square feet. So has the infant grown in fifty-five years!

To this should be added about 3000 square feet for metallography and heat treatment, and about 1000 feet for drafting room. These were originally installed on the fourth floor in Cambridge, but have been given over to chemical laboratories owing to the demand for space in the Chemical Department. The geological laboratories enumerated later are not included in the foregoing figures.

The cost of the laboratories in 1874, as indicated by a report of Professor Richards to the President in that year, was the modest sum $3,780.65, of which $824.25 was for metallurgical laboratory, at that time including a forge, assay furnaces, blower and fire-smelting furnaces for various purposes; and $2,956.40 was for ore-dressing laboratory covering Blake crusher, stamps and concentrating apparatus, boiler, engine, piping, shafting and installation cost.

A somewhat similar estimate, made about twenty-five years later, indicated that the cost of duplicating the laboratory of that date, excluding the building, would be around $15,000. Details of costs in round numbers for the new building in Cambridge show a total of $372,000, divided as follows: foundation, $60,000; superstructure, $121,-

THE TECHNOLOGY SERIES

Unfortunately, Tech men can never avail themselves of every advantage their Alma Mater has to offer and many alumni, who for a period, have been under her guidance have never seen the new plant and have no way of knowing their Alma Mater's increased sphere of activity. This year, THE TECH ENGINEERING NEWS is making a special effort to ameliorate this situation in presenting this series of articles on the new Technology, its business management, the work carried on in the laboratories, and the plans for the future. This series, of which this article and that on page 277 are the sixth, has been prepared by men thoroughly familiar with the phases they treat upon and is as follows:

THE TECHNOLOGY BUILDINGS ..... October
F. J. Whiting, Editor, Stone & Webster Journal.

THE GROUNDS AND THEIR DEVELOPMENT ..... November
H. J. Carlson, President Alumni Association.

THE BUSINESS ADMINISTRATION OF THE INSTITUTE ..... December
H. S. Ford, Bursar.

THE POWER SYSTEM OF THE INSTITUTE ..... January
A. S. Smith, Superintendent of Buildings and Power.

THE ENGINEERING LABORATORIES ..... February
Prof. E. F. Miller, Head of Department of Mechanical Engineering.

THE MACHINE TOOL LABORATORIES ..... February
Prof. R. H. Smith, Assistant Professor in Machine Construction.

THE MINING, GEOLOGICAL, AND METALLURGICAL LABORATORIES ..... March
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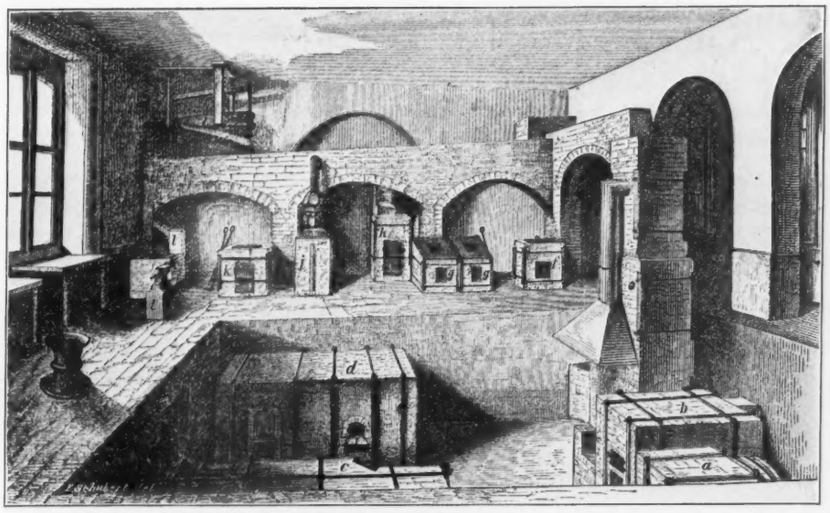
THE PHYSICAL LABORATORIES ..... April
Prof. C. L. Norton, Head of the Department of Physics.

RESEARCH AT THE INSTITUTE ..... May
Prof. H. M. Goodwin, Professor of Electrochemistry.

PLANS FOR THE FUTURE ..... June
To be announced.



THE METALLURGICAL LABORATORY IN THE BASEMENT OF ROGERS BUILDING AS IT WAS IN 1874

000; inside divisions, $47,000; heating and ventilating, $43,000; electrical equipment, $17,000; service piping, etc., $6,000; equipment,* $78,000; total, $372,000.

Technology holds the distinction of being the first school in the United States to install mining and metallurgical laboratories. The credit for this is largely due to Professor Robert H. Richards who, for nearly fifty years, was the guiding spirit in the development which has kept them always up to date and among the leading school laboratories of the country. It is, therefore, eminently fitting that the present ore-dressing laboratory bears the name of the Richards Laboratory, as a memorial of his work at Technology. He had associated with him at different periods Professors Clark, Hofman, Lodge and Ordway, able coöperators in carrying out his ideas. Two of these are now deceased, while Professors Hofman and Lodge are no longer active teachers. Credit should also be given to Joseph W. Revere, '69, of the famous Revere family of copper metallurgists, who put his practical knowledge of metallurgy at the service of the Institute and saw the new furnaces safely through their first trial runs.

A study of the laboratories and their modus operandi discloses certain principles which have been consistently followed, and it appears worth while to set these forth.

The field of laboratory work has been in mining, ore dressing, metallurgy, metallography, including heat treatment and geology.

Mining has been covered only to a very limited extent since practical mining is better learned in actual mines, and the field of laboratory work should not go beyond the use of certain machines, such as drills, pumps and compressors, for the purpose of studying their mechanism, as supplementing and illustrating the lectures. It is a waste of time for a student to spend a laboratory period learning how to pound a drill into a rock. Such knowledge can be easily obtained in practical work later from any average miner, but where can a young graduate in the mining camp find a competent instructor to teach him the fundamental theory of air compression and expansion? Hence, get the theory at school and use a mining laboratory only as needed to give a clear exposition of this theory.

Iron and steel metallurgy does not lend itself to easy reproduction in a school laboratory, since it is very difficult to reduce the blast furnace, open-hearth furnace, Bessemer converter, etc., to the size of laboratory units and obtain successful operation. About all that can be done is to illustrate the chemical principles involved by performing operations of oxidation, reduction and slag formation in crucible furnaces.

Laboratories should not be allowed to develop into museums. Material which has become obsolete should be removed and new apparatus substituted for it. This policy will give the plant an air of practicability, and may even make it difficult to keep things as tidy as one would wish, but it is far better to have the apparatus this way than always all dressed up and enjoying a perpetual holiday.

Neither should apparatus be designed to show principles alone, but should be actual working machines which can be operated and adjusted by the student and which yield results approximating those obtained in practice.

As a general rule, laboratory devices should be reproductions, on a reduced scale, of commercial machines. This saves space, lessens the cost, makes the apparatus easier to handle, adjust and control, requires less material to be handled at the expense of physical effort, allows more time for mental effort, and in most cases teaches principles just as satisfactorily and gives the student just as much information

(*Continued on page 290*)

Courtesy of The Technology Review

THE PRESENT MINING BUILDING IN CAMBRIDGE

This building is an integral part of the main group.

*Including offices and class rooms as well as laboratories but not including old equipment transferred from the Rogers Building.

HOW TO SUCCEED IN BUSINESS

By CHARLES M. SCHWAB
Chairman, Bethlehem Steel Corporation

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As time goes on I find it more difficult to speak of retiring from my forty-three years of business life. In fact, instead of retiring, I find myself drawn more and more into concerns, each of which involves new responsibilities. But the greater the responsibilities, the less I find of the element of personal supervision and the less I enjoy my new work. The thing that has given me the most pleasure and that I am the most proud of is that I keep finding friends and friends — and yet more friends on every hand.

You want me to tell you how you can succeed in life. I know that it is very difficult to convince the great majority of people that men who are in active pursuits of life have any other object in view than the making of money. This is a great mistake. The real leaders of industry, the real men in life, and the real successes in life, are not always the men who have made lots of money or a great fortune.

My idea of the successful life is the man who has satisfactorily accomplished the objects for which he set out, to do something that is worthy of a real American man. Money is often a matter of chance or good fortune, and is not the mark of a successful life. It is not the thing that brings a throb of pleasure or a thrill into my life, and I would not pose as a successful man if that was to be the measure. But when I look about me and see the multitude of friends that I have after forty years of business association with men, when I see the great lines of smoking stacks and blazing furnaces that have come into being because of my interests and activity in life, and when I see a work that I set out to do successfully accomplished and meeting the approval of my fellow men, then a real thrill comes into my heart, and I feel that I have done something worth while. The money you do not think about, as long as you have enough to pay your bills and keep your usiness going. The captains of industry do not keep on working for the sake of making money, but for the love of completing a job successfully. Men who typify the ideal business man in my mind are Mr. Carnegie, the elder Mr. Rockefeller, Mr. Baker, the younger Mr. Rockefeller, and Judge Gary.

One of the dearest friends that I ever had in life, Andrew Carnegie, used to say to me when I went to him with my balance sheet and showed him how many hundred thousand dollars we had made that month or year, "That's interesting, but show me your cost sheet." This is the mark of successful manufacturing, how economically and how well you do a thing, not how much money you make in the doing of it. So, his mark — and he was a wise man — of a successful industry is my mark of a successful life. Set out with some definite purpose in life and accomplish that purpose. There is little that the human mind can conceive which is not pos sible of accomplishment. The thing to do is to make up your mind what you are going to drive for, and let nothing stand in the way of its ultimate accomplishment.

Now, in my long experience in business life and association with men, there are some fundamental things that must not be overlooked. If I were asked to state the most important things that lead to a successful life I should say that, first of all, was integrity — unimpeachable integrity. No man can ever do anything of any great value in life and have the confidence and approval of his fellow men or be successful in his undertakings with other business men if he doesn't have the reputation of being a man of honor and integrity.

I am going to speak of a young man who I regard as the most successful young man I have ever known. If I did not regard him so, he would not be the President of the Bethlehem Steel Company. I am going to speak of a young man that I have known since he was a man of your age — I refer to Eugene Grace. You may have heard of him. He came from Lehigh University. When I first knew him he was a shoveler of coal with an electric crane. From that time on I followed his career, and whatever may have been said of Mr. Grace, you could always depend upon it absolutely that when Mr. Grace said a thing you would know the absolute facts, good, bad, or indifferent. Today, Mr. Grace stands among the great business men of New York and this country, with the reputation of being a man of absolute integrity and a man in whom everybody can place the greatest possible confidence.

A man must also be a true democrat, and not an aristocrat who condescends to talk with any one. The educated man must not get the idea that education necessarily makes him superior to any other skilled man who has devoted his life to mastering one business.

When I first entered the business world in 1879, the United States was producing only one million tons of steel a year; now we produce fifty million. Never was the opportunity and the reward so great as it now is in this reconstructed era. The hardest struggle of all is to be something different from what the average man is. I don't believe in "super-men," for the world is full of capable men, but it's the fellow with determination that wins out.

Bet on the United States if you must bet at all, for any good enterprise in this country is worth more than six or seven per cent. Put your all into any business which depends for its success on your own brains and determination to win. Be not fearful in borrowing money; I have borrowed more money than any other man in the United States, and on less collateral.

Be sure to go into a business that will keep your interest, for you can't handle working men successfully if you only pretend to be interested in them.

If I were able to give you whatever I wanted, I would wish that you might have a rugged constitution, a desire to work, and the great American characteristic of driving onward.

Any man who goes into anything in life and does it better than the average will have a successful life. If he does it worse than the average his life will not be successful. No business can exist in which success cannot be won on that basis.

Another important thing is loyalty. Be loyal. What measure of success I may have won in life I attribute to the loyalty I had for a dear old friend who was my first steel master, whom you, perhaps, have never heard of — Captain Bill Jones.

Captain Jones was a great mechanic, just a natural genius at mechanical things. No education at all. He knew nothing of engineering or chemistry or the sciences. Now I was thrown in, fortunately, with him. I made up my mind that I could be very useful to that man by learning things that he could not learn, and, above all, by being loyal to him and never letting the world know that the things for which he received credit were not his own creation. Did you ever stop to think that a great man in life who has won great acclaim and great reputation is the very man willing to share and give the honor to others in the doing of the things that made him great? The man

(*Continued on page 286*)

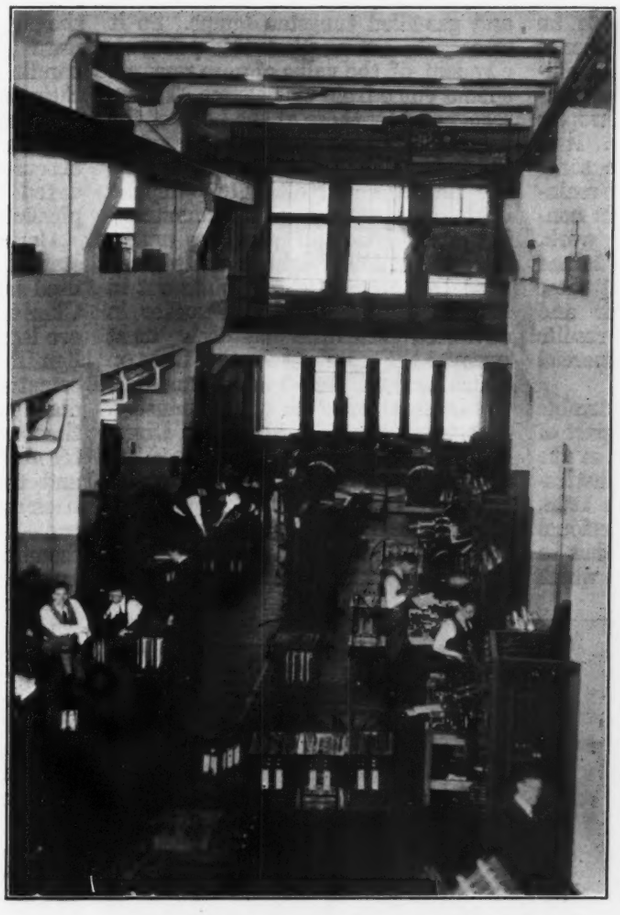
THE ELECTRICAL ENGINEERING LABORATORIES OF TECHNOLOGY

By Prof. F. A. LAWS, '89
Professor of Electrical Measurements, Massachusetts Institute of Technology

Those familiar with the history of the Massachusetts Institute of Technology know that the Department of Electrical Engineering was developed from an option in Applied Electricity established by the Corporation in 1882 at the suggestion of the late Professor Charles R. Cross, for many years the Head of the Department of Physics, Director of the Rogers Laboratory of Physics, and later, Professor in charge of the Course in Electrical Engineering. This development of the Department of Electrical Engineering from the Department of Physics accounts in large measure for many of the salient characteristics of the course in Electrical Engineering as it now exists.

It was natural that, in developing the general plan, great stress should be put on the laboratory side of the work, for the Institute had been the first educational establishment to undertake the giving of laboratory instruction in Physics to students in classes, and the Electrical Engineering Laboratory was a direct development from the Physical Laboratory as such. Class work in the Physical Laboratory was started as early as 1869 by the late Professor Edward C. Pickering, Director of the Rogers Laboratory of Physics, who later became the distinguished director of the Harvard University Astronomical Observatory. Naturally a man of his solid scientific attainments could not fail to leave a lasting impression on any institution with which he was connected. His book on Physical Manipulation, published in 1872, was for many years used as a text in connection with the work of the laboratory. Among Professor Pickering's pupils was the late Professor Silas W. Holman, a great laboratory teacher, an expert manipulator, a man of unbounded enthusiasm and a source of inspiration to his students, and a man who uncomplainingly carried not only the load naturally associated with the teaching profession, but a great burden of ill health as well.

To these two men the Institute as a whole owes a great debt of gratitude in establishing its laboratory work on a solid quantitative basis so that it has become one of the laboratory traditions that a number of experiments well performed, thoroughly understood and adequately reported upon are of far more educational value than a greater volume of work performed and reported upon in a slipshod manner. Those who came under Holman's personal influence can never forget his formative power, whether they be professional teachers or men of affairs.



GENERAL VIEW OF LABORATORY OF DYNAMO DIVISION
Small units of apparatus are placed on the balcony and the larger units are on the main floor all of which is not shown in this picture.

It was natural, when the few electrical experiments in the Physical Laboratory gradually developed into a more extended course and finally into the course in Electrical Engineering Laboratory, that the general educational characteristics of the work should be maintained, even though the subject-matter was greatly changed and continually changing to meet the requirements of the rapidly developing electrical art.

The Measurements Division of what is now the Electrical Engineering Laboratory was the first distinctly professional offshoot of the Physical Laboratory; this was followed in due time by the Dynamo Division, then in 1913 by the Research Division Laboratory, and finally the Communications Division of the Laboratory which is now being equipped. This last is to furnish the additional special laboratory instruction demanded by the newly established option in Electrical Communications.

Serving all of the above laboratories is the power plant on Vassar Street, a general description of which was given by Major Smith in the January number of THE TECH ENGINEERING NEWS.

The general scheme of the power distribution as far as the Electrical Engineering Department is concerned is shown diagrammatically in Figure 1 (see page 292). The departmental substation, enclosed by the dotted line in the diagram, receives current from the power house, generally at 2300 volts, 3 phase, 60 cycles per second, and supplies alternating and direct current for all the laboratories via motor generator sets. In addition, there is a direct connection to the power house via transformers, so that power at 230 volts, 3 phase, 60 cycles per second may be placed on the bus bars. Also the direct current 230 volt bus bar can be energized directly from the power house, so that it is not necessary to operate the substation all of the time. A 240 volt, 25 ampere storage battery is available if exceptionally constant direct current voltages are required.

The 2300 volts, 3 phase, 60 cycle power is transformed in the substation as follows: (1), into 230 volt, direct current by means of a 250 kilowatt induction motor generator set; (2),

(Continued on page 292)

THE GROWTH OF RESEARCH IN AN INDUSTRY

By F. E. CADY, '01
Manager of Research Department, National Lamp Works of General Electric Company, Nela Park, Cleveland, Ohio

Two decades ago the association of the words "research" and "industry" would, in this country at least, have conveyed an idea of an intensive effort directed toward the solution of intricate problems of a technical character arising in the course of manufacturing processes, and having for its object the improvement of those processes or the discovery of new and more efficient ones. The idea of any company setting aside part of its profits to be devoted to the advancement of science would have been considered as chimerical as to expect a business organization to emulate the philanthropies of a Carnegie or a Rockefeller. It is true that even in those days some large industrial corporations maintained laboratories in which, in connection with their industrial work, physicists and chemists obtained results of scientific interest, but these individuals were employed for and were expected to produce results which had a recognizable commercial value.

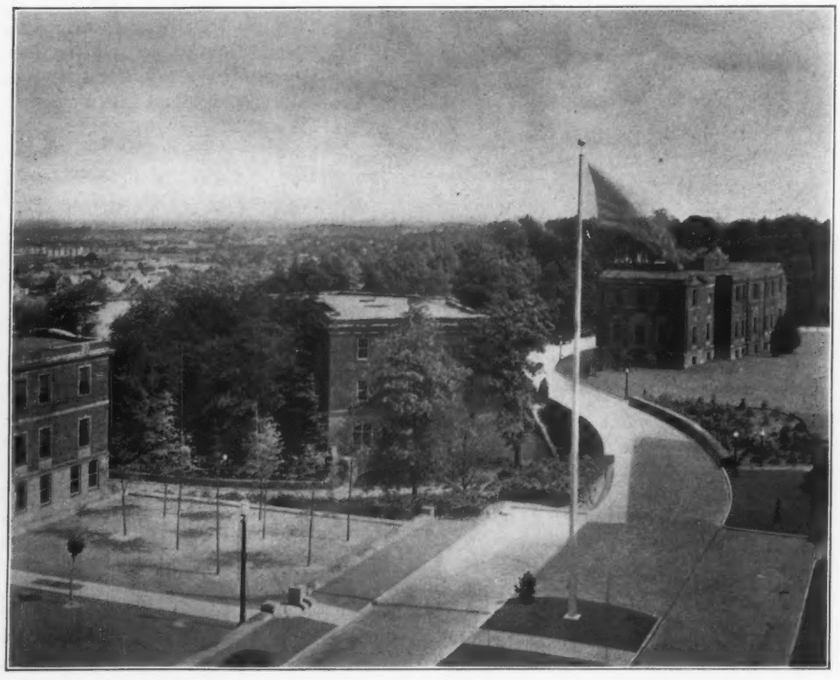
It was, therefore, with considerable surprise and skepticism on the part of those engaged in pure research in the universities and educational institutions that it was announced in 1908, by what was then called the National Electric Lamp Association, that a laboratory had been established which would be devoted to pure research. The lamp industry is one of a number of industries in which the development of the output can be readily traced to the results of scientific study and experiment, and this is particularly true of its development since the advent of the series of so called metallic filament lamps starting with the graphitized carbon through the tantalum, osmium, and the present vacuum and gas-filled tungsten lamps. So it was quite fitting that this acknowledgment of the value of pure research should come from this source. It was recognized by those at the head of the organization that just as the past of the industry had benefited by science the future would ultimately depend upon the more thorough understanding of the laws and principles underlying the action of light in all its broad phases. As Dr. Nichols points out in his inaugural address, the worker in advanced scientific research must uncover the store of scientific facts on which the practical worker can draw to further the growth of the industry.

It was early realized by the Director that the laboratory offered an opportunity for the coördination of the work of the physicist, the physiologist and psychologist, the first to study the laws and principles of the production of radiation, the last two to study its effects. Such coördination, while it might be expected in collegiate institutions, seems to be only too rare. At the same time its advantages would seem to be only too evident. From his contact with the physiologist and psychologist, the physicist realizes that the eye and mind are the all-important factors in the use of radiation produced for artificial illumination. On the other hand the physiologist and psychologist learn from the physicist how to produce, handle and describe radiation used in their researches. A lack of knowledge of some of the fundamental but less well-known principles of physics has obscured and in many cases invalidated much research work in the physiology and psychology of vision.

Curiously enough the laboratory was started in a small building at one time used as an experimental laboratory by Charles F. Brush, whose work on the arc lamp in the early days of electric lighting was so monumental. Two essential adjuncts were started immediately, the mechanician's shop and the library. Subscriptions were placed for all of the most important scientific and technical journals as well as for back numbers of those most frequently consulted. This made available to the members of the staff work which had been done in the past, and work which was going on, thus avoiding duplication. A competent mechanician in the shop made new apparatus and repaired such as became damaged.

Among the subjects studied in the early days of the laboratory might be mentioned the problem of finding why such metals as tantalum, osmium and tungsten are better materials for use in the production of light than other metals. As an auxiliary a study was made of the total energy radiated from the filament of an incandescent lamp, and a method was developed for determining the losses by conduction at the leading-in and anchoring wires. It was found possible by this method to determine for every unit of length of the filament, while heated to incandescence, the energy input, the energy radiated, and the luminous value of the radiated energy. The measurement of light is an extremely important factor in studying its action, and in this connection an elaborate investigation was carried out on the flicker photometer in order to ascertain its value in solving the problem of the measurement of light sources differing in color. A study was made of the cor-

(*Continued on page 288*)



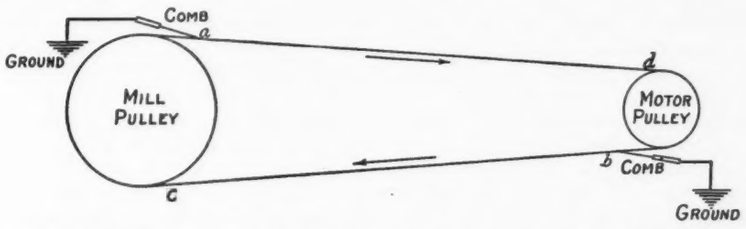
THE PURE SCIENCE LABORATORY OF THE NATIONAL LAMP WORKS AT NELA PARK

STATIC ELECTRICITY AS A CAUSE OF DUST EXPLOSIONS

By PROF. F. A. ROGERS, Lewis Institute, Chicago, Ill., and DR. HAROLD H. BROWN, Hollinsworth and Vose Company, Norwood, Mass.

Static electricity means electricity standing still. If you could get it to stand still, there would not be much hazard in static electricity. The trouble with it is it doesn't stand still, but appears to jump from whatever it happens to touch, and, in jumping, if it hits the air and creates a spark, it is liable at times to cause fire.

You will recall from your old textbook on physics, that as long ago as 600 B. C., the Greeks discovered that amber rubbed with certain substances, such as wool, possessed the property of attracting certain light objects, such as pith of wood or hair. Amber, in the Greek, was called "electron," and from this name we get the word "electricity." It was more than two thousand years afterward, however, that Gilbert, the Englishman — the physician of Queen Elizabeth — found substances other than amber which possess this property of picking up certain little objects when rubbed with certain other things.



COMB DEVICE FOR REMOVING STATIC ELECTRICITY FROM BELTS

The combs have to be placed within a few inches of the point where the belt leaves the pulley to be effective.

Suppose we rub a piece of glass with a silk cloth. Let us also take a piece of hard rubber or ebonite and rub it with catskin. Although the glass will push the silk away and the ebonite will push the catskin away when we bring the ebonite near the glass rod, we find they are attracted. This leads us to the conclusion that there are two kinds of electricity. The kind we get on glass by rubbing with silk we call positive, and the kind we get on ebonite by rubbing with catskin we call negative. Our modern theory explains this in the following fashion. In the hydrogen atom we have a central nucleus which contains a positive charge — it contains about 1799/1800 of the whole mass of the atom. Surrounding, or rather, connected with this central nucleus, but situated some distance from it, we have another small mass called an electron, which contains a negative charge and is about 1/1800 of the mass of the whole atom. In other atoms we have more than one of these negative charges, and in some atoms a good many. When we rub a piece of glass with silk, we rub off some of the electrons; that is, we rub off some of the negative and, of course, that leaves the predominance positive; then the silk contains more electrons than it had before, while the glass contains less electrons than it had before. When we rub a piece of ebonite with fur, we rub some of the electrons off the fur on to the ebonite, then we have what we call a negative charge, or an excess of the negative on the ebonite.

In dealing with static electricity we should remember the discharging power of points. It was Benjamin Franklin who discovered the discharge power of points and made use of it in lightning rods. In this connection, one fact should be borne in mind, that is, that electricity will travel by the shortest path possible. For example, if two leyden jars are fully charged, one with positive and the other with negative electricity, even though they may be connected by a wire about four feet long, if the tops of the jars are brought close together, a spark will jump the gap rather than flow around the long wire.

Although we all know what a thunderstorm is, there has been a great mystery as to the causes of atmospheric electricity. I want to go into this briefly, because I think it bears on the hazard in connection with the handling of gasoline. During 1908 and 1910, Dr. J. C. Simpson of the British Meteorological Bureau in India performed a long series of experiments to find out the causes of atmospheric electricity. He finally discovered that when a drop of water falls through the air at a speed of about twenty-six feet per second it breaks up into spray. That is, you take a solid drop and when the speed reaches about twenty-six feet per second the drop breaks up, and when it breaks up the fine part of the spray seems to be negatively charged. It seems that the friction of the air, or rather the breaking up of the drop by friction, separates the electrons from the main body of the drop. The electrons, of course, carry the negative charge.

In a thunderstorm the thunder cloud shows a boiling effect on the top. You see them sometimes in the evening, on the horizon, and will usually see on the top a boiling, or cauliflower effect, that seems to be caused by an upward draft of air. Simpson found that this upward draft carried water up with it. The upward draft must, then, have a

(*Continued on page 302*)

A CEREAL MILL BEING DESTROYED BY FIRE

This fire was caused by a dust explosion in the feed grinding department and was probably due to static electricity.

MONTHLY NEWS

New Electric Furnace for the Treatment of Non-Ferrous Metals. A new electric furnace has been tried, which seems to give some remarkably good results. It is claimed that whereas a coal-fired furnace for the treatment of brass costs $16.00 per ton to operate, and an oil-fired furnace about $14.00 per ton, this new electric furnace brings the cost down to less than $8.00 per ton.

This new furnace has also the great advantage of doing away with the very big losses of zinc, in the manufacture of brass, due to the vaporization of the metal as a zinc oxide.

It has been figured that this country would have saved $20,000,000 if the brass treated for war purposes in 1917 alone had been melted in electrical furnaces.

The United States Bureau of Mines proclaims that the brass melting industry would save between two and three million dollars a year by replacing the old systems with electric furnaces.

This new furnace has been found most efficient; it follows the "induction type" principle.

Reciprocating Engine. A new type of reciprocating engine, for which the inventor, E. N. G. Reagan, claims a greatly increased horse power for a given pressure, is a radical departure from the present-day type.

It has no base, no crank case, no crank shaft, no connecting rod, no flywheel, no gaskets or packing glands, no screws or bolts in its moving parts, and is controlled by one lever in all positions of speed, viz., forward, neutral, reverse, and brake.

The engine has the same torque, from the moment of starting up to 950 revolutions per minute, and may be constructed of any desired size, with an even number of cylinders, using a sight feed. The steam generator is of the safety tubular boiler type. It contains automatic control of water and fuel. The burner is a steam atomizer, using crude petroleum as fuel, eliminating cloggings of pipes.

The steam is taken from the generator to the engine at about 60 degrees Fahrenheit, passing through the engine to the condenser, turning the steam back to water and returning to the boiler at about 205 degrees Fahrenheit.

It is claimed that the engine can be compounded to any working capacity. The engine was given a careful test in the laboratory of the University of Detroit and is said to have proved entirely practical and superior to other engines in many ways.

It is intended for use on farm tractors, concrete mixers, road machines of any description, steam shovels, street cars or interurbans, elevators, hoisting machines, motor busses, motor boats.

This engine at the present time shows a mechanical efficiency of 92 per cent. The demonstrating model weighs 160 pounds, developing 45 horse power at 120 pounds steam pressure.

Simplified Paving Brick. The Bureau of Standards has just published the results of a recent conference of the trade looking to elimination of unnecessary variety of shapes and sizes. The fact that very little impetus is needed to put through a really meritorious project of this character is indicated by noting that it took less than six hours discussion to reach an agreement eliminating fifty-five out sixty-six existing varieties; and that at a later meeting the remaining eleven were further reduced to seven. Paving brick will hereafter be made only in sizes 3 by 4 by 8½, 3½ by 4 by 8½, 3½ by 3½ by 8½ and 3½ by 3 by 8½ inches, with certain of these sizes made up in different styles so that there are in all the seven varieties mentioned. It will be noted that all bricks, without exception, will be 8½ inches long.

— *Scientific American.*

Hardening Steel Without Scaling. Processes for hardening steel without scaling have had much attention in England during recent years. One of the most successful hardening surfaces that meets these requirements is that made under the Walters patents. In this furnace the work is suspended in a vertical tubular muffle heated by an electric resistance winding of nichrome. The atmosphere in the heating space is coal gas, which is admitted to the lower end of the muffle and escapes slowly through an outlet near the top. The atmosphere, therefore, is non-oxidizing and, in fact, slightly reducing. When the work has reached the required temperature, it is dropped straight into a quenching tank without coming in contact with atmospheric oxygen. The result is a surface quite free from pits or scaling. At present the furnace is in use chiefly in tool rooms and for laboratory purposes, but larger furnaces have been used with great success in the hardening of crankshafts, rolls and other heavy work up to 200 pounds. — *Machinery.*

New Planet. A new asteroid was recently photographed at the United States Naval Observatory. The planet was first sighted on December 22 as a by-product of the regular observatory, and is in the constellation of Orion and has a magnitude of ten. At present there are less than 1000 of these planetoids known, the largest being about 450 miles in diameter. The diameter of the new planetoid has not yet been measured. The planet was independently discovered by observatories in Algeria and Spain about ten days previous to the observations at the Naval Observatory.

Helicopter. The new helicopter which has recently made successful flights at McCook Field at Dayton, Ohio, was invented and built under the supervision of Dr. George de Bothezat by the United States Air Service Division at an estimated cost of $200,000. According to information made public by the inventor, the helicopter weighs 3,600 pounds, is propelled by a 170 horse power motor, with a total blade area of 900 square feet, four propellers, each having six blades. The diameter of the propeller is twenty-five feet. The plane is capable of rising vertically in the air and hovering over one spot. The descent is made straight downward, but it can travel horizontally as well as vertically. Dr. de Bothezat has invented airplane and gyroscopic apparatus and designed mathematical and aeronautical instruments, some of which are in use now at McCook Field. Dr. de Bothezat is the author of the supposed first book on airplane mechanics published in Paris, France, in 1911.

Electrification of the St. Gothard Railway that crosses the Swiss Alps has finally been completed, after nearly

nine years of constant work. The St. Gothard Railway is one of the great arteries of European railway traffic. To electrify this road the whole line practically had to be reconstructed. Two large power plants had to be built, bridges had to be strengthened, and telephone and telegraph lines had to be relaid. One of the power plants was built at Amsteg and the other at Piotta. These two plants and five substations for transformation of the current form the complete power system.

Large Radio Station. Construction of a high-powered radio station in China, at a cost of $13,000,000 is to be started immediately by the Federal Telegraph Company of Delaware, a company jointly owned by the California Federal Company and the Radio Corporation of America. The enterprise will bring the control of wireless communication with the Far East into American hands for the first time.

The main and secondary stations are to be built at Shanghai. It is claimed that the main station will be the most powerful in the world, and it is estimated that the construction of the entire project will require about twenty months. In it will be installed duplicate 1,000 kilowatt arc transmitters of the Federal type. Subsidiary radio stations will be erected at Canton, Pekin and Harbin, this providing the first wireless communication between the different sections in China.

Engineering Library. An engineering library, the largest and best of its kind in the West, is being established for Colorado engineers. It is modeled after the library of the United Engineering Societies, and will be located in a room of the Denver Public Library. This room, the Technical Room, will be set apart and remodeled to properly care for the valuable collection.

The money for establishing the library was secured through the foresight of the Colorado Engineering Council at the framing of the Engineer's License Law. The council, consisting of delegates from the seven largest technical societies in Colorado, feared that the fees paid by engineers for securing licenses and renewals would be absorbed for ordinary State purposes. It therefore inserted a clause in the law specifying that the money so obtained shall be used for "the purchase of technical books and publications."

The original contribution to the library consists of over three thousand books now owned by the Colorado Scientific Society. To this will be added the scientific collection of the Denver Public Library and books to be purchased from an available fund of $12,000 and an annual income of from $2,500 to $4,000. A photostat will be installed for furnishing photographic copies of rare drawings, papers, or articles that cannot be readily circulated.

Boll Weevil Destroyer. If experiments which have been conducted prove successful in practical use, calcium arsenate is bound to be superseded as a boll weevil destroyer. Dr. Cox, President of Cox College is confident that the boll weevil destroyer is no longer an experiment, but can be applied on a large scale to rid the South of this cotton parasite. Dr. Cox's experiments on his 1800 acre farm in Bullock County, Alabama, show that using his preparation he can raise a crop of cotton as fine as that of pre-weevil days. The destroyer is a poison, is soluble, and is applied as a liquid by means of spraying. The plant is inoculated by the liquid, which also forms a gas two and one-half times heavier than air. This gas, which is colorless, kills the weevil and larvae without injuring the plant.

The poison is superior to calcium arsenate as only a few applications to each crop are necessary. Rain will not wash it away since, being soluble, it is taken up by the plant. This product will soon be manufactured at Atlanta in large quantities.

Gasoline Electric Car. As the result of efforts to manufacture a self-propelled railway car which would combine the utility and flexibility of the electric car and the low installation cost of the gasoline car, Swiss engineers have developed a new car which is said to combine these advantages successfully. The car is so designed that the gasoline motor, which is 200 horse power, four cycle Sulzer engine of the new RV type, can be operated at almost constant speed, thus favoring the most economical fuel consumption.

The actual motive power is electricity, a specially designed electrical transmission system making various speeds possible without changing the speed of the gasoline motor.

Under trial tests the car has been found to be extremely economical to operate. The fuel consumption for 1 km. is, when no trailer is attached, 0.6 kg. of gasoline, or approximately 0.262 gallons per mile. Thus a storage capacity of 350 litres (92.47 gallons) would be sufficient to give the car a traveling radius of about 500 km. or 314 miles. Running on a level roadbed, the car, without trailer, can attain a speed of about 44 miles per hour, and with a 20-ton trailer 37.5 miles per hour can be reached without overcrowding the motor.

The most extensive test made on the car was conducted on the line between Winterthur and Frauenfeld, near Zurich, Switzerland. The distance between the two towns is ten miles, and on the trip to Frauenfeld from Winterthur, 1.85 gallons of gasoline were consumed. Returning 3.44 gallons were used. Thus a total of 18 kg. of gasoline were used and at the prevailing price of 12 francs per 100 kg. the cost to run the car 20 miles was 2.2 francs, or 44 cents.

The car is constructed to operate on standard gage track, and is fitted with two driving platforms, thus permitting it to be run on tracks where turntables are not available. There are seating accommodations for 69 persons, and in the aisles there is standing room for 16 more. The total length from the front to rear buffers is seventy feet. Five axles are used to support the weight of the car which is approximately sixty-five tons. — *Journal of Electricity and Western Industry.*

Staggered Rail Joints are at the moment the subject of keen discussion in British Technical papers. One authority claims that the staggered joint as used in America causes train swaying. British self-satisfaction is keen at the discovery of a considerable volume of American opinion in favor of the British system of opposite joints

New Motor Fuels. The South African Railways have recently awarded a six months' contract to the manufacturers of "Natalite," a gasolene substitute for use in motor transport service. "Natalite" is a sugar cane distillate made largely from waste materials and was offered at a much lower price than gasoline.

Another example of motor fuel substitutes appeared in the following extract from the *South African Journal of Industries.* The raw material from which the fuel is distilled is the prickly pear. The prickly pear alcohol was distributed to three garages in the Orange Free State and a public demonstration of its starting, pulling and flexible powers in three makes of cars was held in Bloemfonteen. The drivers reported the fuel equal, and in some respects superior, to the highest grades of gasolene imported from the United States. Government experts also reported the spirit free from corrosive and other agencies detrimental to internal combustion engines.

EDITORIALS

THE STUDENT AND WORLD AFFAIRS

For a century and a half the voice of the people has been increasingly the greatest influence in the determination of the policy of the world's governments. Today public opinion is easily the dominating factor in every one of the world's leading nations.

This tremendous power that the public holds in its hands is not always a power for good. It may as well be a power for evil. And if the governing in the world is to be done wisely, public opinion must be wisely and thoughtfully formed.

Mr. Frank Simonds, who has for some years contributed monthly articles on the political and military situation in Europe to the *Review of Reviews*, indicated, in a recent issue of that magazine, something of the baneful influences exerted by a public opinion formed, not rationally, but prejudicially and in haste. Speaking of the policies of the leading European countries, he shows quite conclusively that generally the premiers and prime ministers have had, in determining their course, a choice of two alternatives. Either they may do the thing that ultimately will prove the best but which an irrational public opinion opposes or he may do what the public opinion demands, knowing full well that it leads but to further trouble.

In the European countries where the *vox populi* is so swift in its action that he who seems firmly ensconced as premier today may be a mere citizen in a week, these men have but one choice, to do what public opinion demands. For however patriotic and willing for sacrifice of self for country the individual may be, it is not difficult to realize that, sooner or later, some one will be forced to do as the public demands.

The mechanism of our own government does not allow for such sudden changes in administration but it does allow a change of public opinion to bring about a situation fully as distressing. The examples of friction between the executive and legislative branches of our government have been too numerous and striking in recent years to need much comment. Suffice it to say that with the legislative bodies and the President at odds, the functioning of the government comes very near a standstill.

So long as public opinion has this power for good and evil, and despite such paternalistic measures as the Eighteenth Amendment, this seems to be for a long time, public opinion must be rationally and wisely formed. The college students of today will generally be the leaders in all fields of endeavor tomorrow. Upon them, as such leaders, will fall the burden of controlling the formation of the future public opinion. That they do it well and wisely necessitates their having a knowledge of the facts in the case, it requires them to have some knowledge of the world's governments and of the trend and meaning of current political events. To be thus acquainted with world and national politics one must read the reliable publications of the day. Hence it becomes incumbent upon the present college student to develop in himself the habit of reading authoritative articles and of forming his opinions only after a consideration of all sides of the question. Today this habit may be of little direct value to him, though he no doubt will find it interesting as well as informative, but tomorrow it will enable him to live under a government more wisely conducted and more effective in results.

THE OLD ORDER CHANGETH

It is hardly probable that the advent of Dr. Stratton to his duties as President has had any direct connection with the movement toward a fuller and deeper Technology tradition and spirit. It is an interesting coincidence, none the less, that the coming of our new President, who has expressed his approval of several manifestations of this movement, should find feelings and thoughts that many Tech students have cherished for a considerable period of time, struggling for expression in accomplished changes. That this tendency has had no small opposition has brought it the more forcefully and completely before the student body.

The first concrete manifestation came with the appointment of a committee from the senior class to consider the matter of wearing the cap and gown at graduation. This committee investigated the matter and reported it as their finding that the wearing of the cap and gown was advisable. A representative group of approximately fifty men was called to a meeting, the proposition placed before them and opinions on the matter requested. It developed that there was no one of this group who did not favor the adoption of this custom. A meeting of the class was then called to discuss the matter and, if possible, arrive at a decision.

As is customary, but a small fraction of the class attended. What this meeting lacked in quantity of attendance it made up in quantity of discussion. This latter commodity was much more distinguished by its volume than by its quality. The logic of neither side could accurately be styled crushing. Nothing was decided here, and recourse was had to that court of ultimate decision, the class ballot. This court declared itself, by a safe majority, to be in favor of the use of the cap and gown.

From the first rising of the curtain on this particular drama the whole affair was spiced with delightful minor incidents. The scenes between the main acts added no small amount of interest and illumination to the major performance. It was to be regretted that a tendency toward personalities was observed in several cases. Through the whole discussion, however, there was the thought that the thing was a question of more than just caps and gowns. And so it is. Whether the senior class this year wears caps and gowns at its graduation exercises or not is but one side of a many-sided question.

The heart of the matter is not readily discovered. To the present author it seems to lie somewhere in the direction about to be indicated. Probably the evolution here presented is not wholly accurate. Its verification requires not only a knowledge of Technology history as seen by the outsider, but also an intimate acquaintance with the student feelings, thoughts and sentiments over the span of years that have seen Technology's growth.

Technology was founded as a school for men who could and wanted to work. It was a place for this type of man to come to and gain knowledge

of a practical sort. Because it was a school for serious work the standard of accomplishment was set high. The faculty, therefore, made it a principle not to distinguish by any sign from them the more excellent scholars from the just passable. To have completed one's course of study and to receive one's degree was to have accomplished enough to set the Technology graduate apart as a superior man; he needed no *summa cum laude*.

The Institute founders, still considering that they were dealing with men, did not impose their wills upon the students outside the classroom. Men should be able to care for themselves and do the manly thing.

The attitude of serious-mindedness and policy of holding the Institute diploma as the highest scholastic honor obtainable made for Technology the wonderful reputation it enjoys today. In those early years Technology stood head and shoulders above every other school of the kind. There were but few of them and Technology was the pioneer. As the years have passed "Institutes of Technology" and "Polytechnic Institutes" have sprung up all over the country. These schools have been able to build up reputations also, and the "Boston Tech" man, though still acknowledged as a graduate of the country's greatest engineering school, is no longer, merely by merit of his being such a graduate, a man apart and above. One more change of importance has taken place as the years have passed. Technology has grown. The student body is no longer a small, select group.

Before considering the effect of these changes it is necessary to realize that every one striving for something, working hard over an extended period for some object, wants a realization of what that object is, what it means. If he cannot get this much, he wishes at any rate some outward manifestation of the fact that when he has accomplished that object he will have done something worth while, worth recognition. It is not enough that he should be just told that such is the case. He wants to look forward to the time when, his object achieved, he will receive recognition for his work; and he wants to be able to visualize that recognition.

In the early days of Technology's history the Technology student had these things in a way that he has not today. He was then a member of a small group of men doing something that had never been done before. The group was small enough so that acquaintance throughout the whole student body was easy. The Technology student needed no graduation ceremony to look toward as a manifestation of what his work meant, he had but to look around him and see that there were no others like him; he could see that he was or would be, when he graduated, a man apart. Today the Technology student sees some three thousand others like him, he knows that there are scores of technical schools in the country, and he no longer sees just how Technology is going to make him a man well above the average intellectually. He believes that it will or he would not have come, but with only that belief, unsupported by anything tangible, he finds he has moments of doubt. He wants his manifestation, his sign.

He think he sees that sign in his graduation ceremonies, but he finds that they are, frankly speaking, a farce. His faith is again shaken. But because he is quite sure of what he wants, he sets out to make those ceremonies dignified, beautiful and full of meaning. He sees the wearing of caps and gowns as a step in this direction. And so he strives to have them used. This initial step has been taken not, it is true, with the unqualified approval of the class, but at least with the backing and enthusiasm of a substantial majority. And this will not be enough. The work will be advanced still farther. With this first step taken it will be for the Class Day Committee to pick up the work and carry it along to a satisfying conclusion. The ultimate in this direction will not be reached this year, probably; but it is inevitable, and the graduations of future years will be not boresome, tiresome affairs featured by an undignified distribution of diplomas, but instead simple, beautiful ceremonies that will leave a lasting impression on the hearts of the graduating classes.

THE HONOR SYSTEM

It is rather a pity that among individuals who have reached a stage of mental development which enables them to enter upon a college education, we always find a few who are so ignorant of the fundamental principles of ethics as to require some sort of check upon their honesty. But as we always do find these backward individuals in our institutions of higher learning, we are forced to look at the situation squarely and to devise the best means of helping as well as restricting the actions of these undeveloped characters. When confronted with the problem, one of the best remedies that suggests itself to our minds is some sort of an honor system.

The Institute, at present, is confronted with this problem, and it is imperative that we find the best solution. Serious consideration should be given to the honor system to find out whether it is an adequate and desirable answer to this perplexing question. It might be well, in this connection, to review some of the facts concerning the honor system.

Data from other colleges having the honor system indicate that in many of them it is successful, while in others it does not work at all, but a proper classification of these data shows that it can be predicted without fail whether or not such a system will work. Where the number of men is sufficiently small so that all are well known to each other, a tacit agreement that "there is no dishonesty here" is all that is necessary, and there is none; but where the number of men involved is larger, this does not work. In this second case, however, the honor system does work when it is sponsored by a committee elected by the student body and ably seconded by the public opinion of the institution. The force compelling obedience in this case, when a man's will does not seem to compel it, is the censure of his conduct as expressed by his fellow students.

Course IV has been the pioneer in bringing such an honor system to the Institute. That it has been highly successful is amply testified to by the fact that it has remained in continuous operation ever since its adoption, to the complete satisfaction of both faculty and student body of the Architectural Course.

Very recently Course X instituted a similar honor system for students in the Chemical Engineering Course. Its life has been too short to say definitely whether it will work well or not, but if the spirit shown by members of the senior class in this course is any indication of success, it certainly will not fail.

The matter of an honor system for the Institute as a whole is a matter for the undergraduates to determine. As one member of the faculty has said, "It must come from the students and cannot be instituted by the faculty alone." It is therefore a subject which every undergraduate should give some careful thought and study to.

Perhaps the best suggestion which can be offered at this time is that every course should institute and try out the honor system within its course. A chance will then be given the students to find out what it is like and whether it is practical. At the end of a sufficiently adequate time, if enough courses report in favor of it, there is no doubt that the honor system should be adopted for the Institute as a whole.

The Index for Volume III of THE TECH ENGINEERING NEWS appears on the last two pages of this issue.

HYDRAULIC WAVE TRANSMISSION OF POWER

By MAJOR F. JOHNSTONE-TAYLOR
British Army

A good deal of attention is being paid in England to a new form of hydraulic power transmission known as wave power. The invention of a Roumanian engineer, Mr. Continesco, it is the outcome of apparatus designed by him and introduced to the British Government during the war, known as the C. C. Interrupter Gear, by means of which it was rendered possible to fire a machine gun through the propeller of an airplane without hitting the blades, the mechanism, of course, being synchronized with the speed of the motor. The system is now being applied to such purposes as operating rock drills in mining; in fact, it is put forward as an alternative to compressed air for this and similar purposes.

In ordinary hydraulic power transmission the water merely acts as an indefinitely long and flexible connecting rod between the accumulator and the tool using the power.

These pumps cause a series of hammer blows on the water in the transmission system, which are transmitted to the operating piston of the tool and reflected back to the pump plunger in rapid succession. It should be noted, however, that there are certain points in the connecting pipe where there is no fluctuation of pressure, and a tool placed at these points could not be operated and this fact distinguishes wave transmission from the ordinary hydraulic system.

Wave transmission depends upon the impression, first of all, of a constant mean pressure on the water column, and secondly a rapidly varying periodic pressure, giving rise to a continuous train of compressions and rarefactions in the water. It is important to note that the point of generation of the waves must be connected to the point at which they are applied by a pipe whose length is equal to half the wave length. This wave length depends upon the speed of the generator in revolutions per minute = n and upon v = the velocity of sound in water = 4800 feet per second; that is to say, if n = 2400 revolutions per minute, the wave length = 60 v/n = 4800/2400 x 60 = 120 feet. The pipe need not be straight.

The generator is shown in Figure 1; such a piece of apparatus being entirely suitable for direct coupling to a petrol or electric motor. The usual speed is 2400 revolutions per minute.

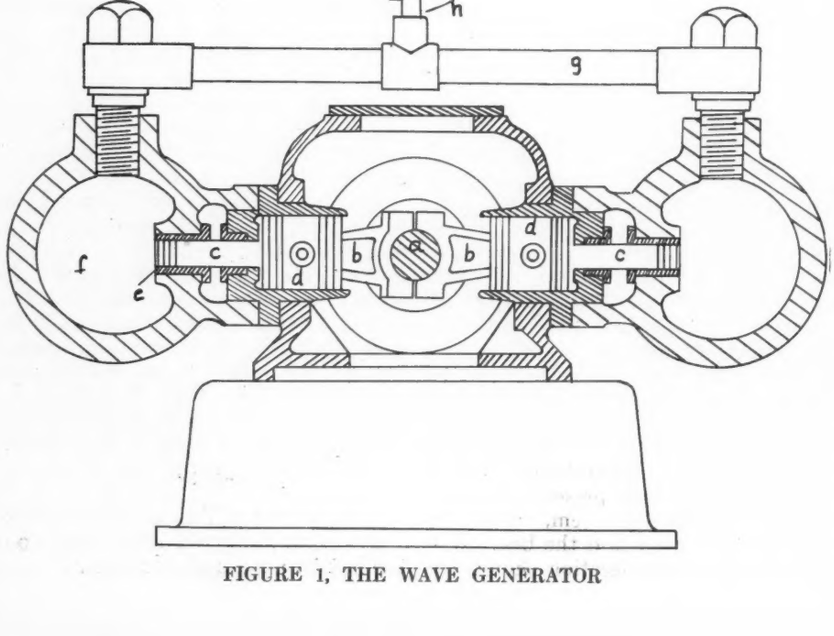


FIGURE 1, THE WAVE GENERATOR

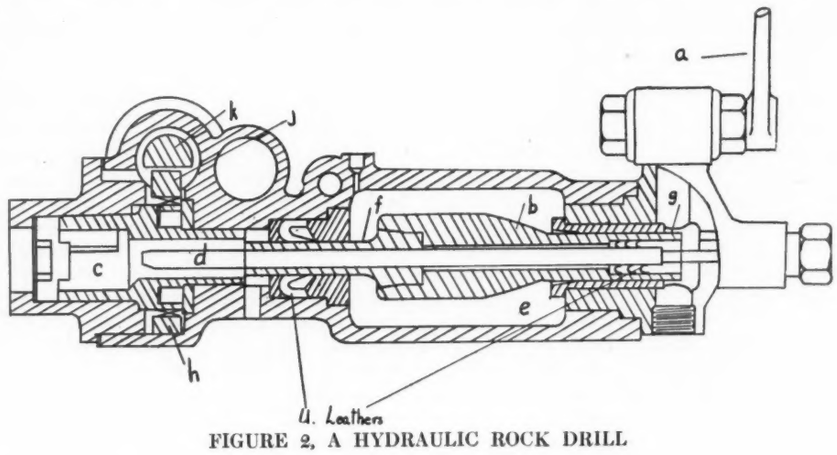


FIGURE 2, A HYDRAULIC ROCK DRILL

The crank a transmits motion by means of the short connecting rods b to plungers c which have guides d, forming crossheads. The plungers which are packed with cup leathers work in bushes e e. These bushes are screwed into chambers f f, which are termed "capacities." It should be noted that they are connected by pipe g.

The diameter of the plunger c c is usually one and one-half inches, and the stroke three-quarters of an inch, giving a total net displacement in f f of about 2.65 cubic inches per revolution, ninety-four per cent of which represents actual compression of the water; h is an air-expelling valve for use during the priming of the apparatus. At the end of the crankshaft towards the observer is a gear-driven lay shaft actuating two other plungers at a considerably reduced speed; one of these serves as an oil pump for forced lubrication, the other serves to provide the make-up water referred to, to prime the system, and to maintain the mean pressure before stated as essential. This latter is regulated by a spring-loaded valve.

The rock drill is shown in Figure 2. The pipe line is connected to the operating cylinder through a rotary valve a to the end of the plunger b. The drill is held in chuck c, rotary motion being given to it by water by-passed for the purpose between two successive blows.

(Continued on page 290)

Movie directors, please copy

IN fiction and the movies all college men naturally fall into two groups. Those who pass their days and nights "Rah! Rah!"-ing and snake-dancing; and those who never appear except with evening clothes—and cane.

The man who works his way through college simply doesn't figure.

Taking care of a furnace, running a laundry, waiting on table, tutoring, covering for a city paper, working in shop or office in vacation—all this may be lacking in romantic appeal, but it is an essential part of the college picture.

And a valuable part. The whole college is the gainer for the earnestness of men who want their education that hard.

Valuable to the college, but even more to the men who travel this rough going. They learn an important lesson in Applied Economics—the amount of sweat a ten dollar bill represents.

If you are one of them you may sometimes feel that you are missing a good deal of worthwhile college life. If you are not, you may be missing a good deal, too.

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HOW TO SUCCEED IN BUSINESS

(*Continued from page 276*)

that will selfishly stand alone and proclaim that he is the man who has done these things, never is the man who really did them. My own experience is that there is no real effort in life that is not done better under encouragement and approval of your fellow men.

A man goes along then with greater confidence. You must learn to let others share with you in that which you are are doing, and honor and credit will be reflected upon you for so doing.

Marshal Foch, the great commander once said to me: "This great military, staff is like an orchestra, and each one fills his place. Each is equally important in the functioning of the whole. If the baton is in my hands it is merely a matter of chance, but we shall see to it that each man in this staff gets recognition for that which is due." You never heard a great man say, "I did this," or "I will do that."

In the management of my great enterprises I have yet to find fault with any man. If a man is such that you must find fault with him to get the best out of him, he is not a man to be desired in an organization. Show me the man that will do his best under approval, and I will show you the man that has within him the elements for successful going ahead.

Now, to come back to loyalty. Be loyal to the people with whom you associate at the start. When this good Captain Jones came to the end of his life's work, do you not suppose it was worth more to me than anything else to have him say: "That is the man that helped me to do these things?" Remember always that it will but attract attention and credit to yourself to share it with those who help you. Be loyal when you start life, wherever you start. Make your employer feel truthfully that you are sincere with him; that you are going to promote his interests; that you are going to stand for the things which he represents; that you are proud of being a member of his staff, and there is nothing that will reap you a richer reward. Loyalty above all!

There are other things in life than mere work. I believe an appreciation of the finer things in life, the learning to know the beauties of literature and art and music will help any man in his career. A man to carry on a successful business must have imagination. He must see things as in a vision, a dream of the whole thing. You can cultivate this faculty only by an appreciation of the finer things in life. No active business life, whether it is manufacturing or something else, should prevent you from enjoying the beauties of life. These finer things will contribute to your success.

Be friendly. When you have friends you will know there is somebody who will stand by you. You know the old saying that if you have a single enemy you will find him everywhere. It doesn't pay to make enemies. Lead the life that will make you kindly and friendly to every one about you, and you will be surprised at what a happy life you will live.

I want to tell you a little more about this man Grace, because one often sees the points in a successful life best by analyzing a single individual. I told you of his great faculty of making good, no matter in what position he was placed. This boy went on and on. Above all, he worked hard with the brain that had been trained in the university to think and concentrate upon the subject that he was thinking about until he had reached a satisfactory conclusion. Now, that is the great point, to concentrate and think upon the problem in mind until you have reached a satisfactory conclusion in your own mind, and then finally go ahead. If you have made a mistake, all right. Never find fault with a man because he has made a mistake. It is only a fool that makes the same mistake the second time. I tell a story of my own experience with Mr. Carnegie, as showing what this might mean.

As chief engineer of the works, I had just built a converting mill. I went to him and said to him: "If you will give me the money to build this mill I can save fifty cents a ton." Of course he provided the money, and the mill was built. He came out to see it. I walked around with him. He saw the look of disappointment in my face and said: "Charlie, there is something wrong here. What is it?" I said: "It is exactly what I told you, and it is better than I told you. We save more than I said. But I don't mind saying that if I had to do the whole thing over again I would do it so and so. I made a mistake in that particular." He said: "Can you change it?" I said: "No." He said: "What does it mean?" I said: "It means tearing it down and doing it over again." He said: "Go ahead and do it. Don't make the same mistake a second time." Do you suppose if he had been a fault-finding man I ever would have told him? Not at all. He brought out the best in me. When that mill was torn down and a second took its place it was as great a success over the first as the first had been over the old one,

Mr. Carnegie had my confidence, and I had his confidence. He believed in everything I had told him. If I had told him something that was wrong and not admitted my mistake, he would never have helped me to progress, and his works and his great establishment would never have progressed as they did.

Now, in my own establishment you will be interested to know something about how we do things. You boys will all, probably, have to start work on a salary. But the quicker you get out of working for a salary the better for all concerned. In our works at Bethlehem and San Francisco, and all over the United States, I adopted this system: I pay the managers of our works practically no salary. I make them partners in the business, only I don't let them share in the efforts of any other men. For example, if a man is manager of a blast furnace department, he makes profit out of the successful conduct of his department, but I don't allow him to share in the prosperity of some other able man in some other department of the establishment. I give him a percentage of what he saves or makes in the department immediately under his own control and management. For example, if it takes a dollar a ton to make pig iron, and it takes him a dollar a ton to make pig iron, I say to him:

"Well, you are no better than the average manager over the country. Therefore you are entitled to only the usual wages. But if you can make pig iron at ninety cents a ton, you are entitled to share with me in a large part of the profits. And if you make it for forty cents or fifty cents a ton, you share to a very large degree."

Therefore, I don't care how much a man earns. The more he earns the better I like him. I pay in what I call bonuses to the various superintendents and managers of the different establishments more money for their successful management than I pay the stockholders of the concern in dividends. And it will surprise you to know the great sums of money that some of these men make. I would be afraid to tell you for fear of discouraging you in your start in life. But I don't mind saying that forty, fifty, sixty, a hundred thousand dollars a year for these men is not infrequent. And in the case of men like Mr. Grace, well, many, many times that.

If you have any influence in the world to get you a start in life, don't use it. The worst thing that can happen to a man is to start life with influence. He has to do twice as well as the fellow that starts upon his own merits, because, after all, it depends on the general opinion of all those around you

(*Continued on page 288*)

SALEM GLASS WORKS

The Manufacture of Glass

ORIGINALLY, skilled men toiled long and hard to produce even one piece of glassware. Quantity production was unknown, but quality was something no one ever dared neglect. It was the great feature of their work and as a consequence, today we can readily understand why such fine pieces were produced, although the labor involved in making them was tremendous.

Now, modern machinery makes quantity production readily obtainable. But quality is in no way sacrificed, for every forward step of the industry tends to place more and more emphasis on this phase of the work. In fact, today, this development of scientific knowledge and management has made possible the production of far more perfect ware than could be obtained with the old methods. Thus are the two important factors, quality and quantity, linked together, with the result that glass may play its very necessary part in our everyday life.

THE SALEM GLASS WORKS, better known to its older friends as CRAVEN BROTHERS, one of the pioneer glass bottle manufacturers in this country, has steadily grown with the industry until today they are noted everywhere for their fine products, their faultless service and their absolute integrity.

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Nothing is impossible when it comes to making better goods or giving better service

HOW TO SUCCEED IN BUSINESS

(*Continued from page 286*)

as to how competent and successful you are, and when everybody says that you do well because of the influence back of you, then you have to do twice as well as otherwise. If you are going into any manufacturing establishment, don't go there by reason of any influence you may have. Start upon your own merits, and start in some lowly position, no matter what it is. Be a laborer, if you will. I don't know but that is the best way to start.

This great war has taught us many things. The one thing it has taught us above everything else is that the true life is the life of modern democracy and simplicity, that it is not one of show or of extravagance, that we are men because we are men and because we have the true instincts of men, and we are not men because we are rich or because we occupy a high social position or because we have influence.

Go at your work. You may not find yourself the first year. You may start at work that you think will not be agreeable to you. Do not hesitate to change. If you find that it is not according to your tastes and ultimate ambitions, then change and go into something that is more pleasant. No man can be successful at work if he doesn't find the work he has to do pleasant. No man can ever do a thing well that he is not interested in. When you start in life, if you find you are wrongly placed, don't hesitate to change, but don't change because troubles come up and difficulties arise. You must meet, overcome and conquer them. In doing so you will make yourself stronger for the future.

Then go on and select your work. Let us suppose you become a craneman. Suppose you become clerk in a lawyer's office. Give the best that is in you. Let nothing stand in the way of your going on.

Opportunities must come naturally, and the only way that they can come naturally is to give your whole heart, give your whole soul, give your every thought, give your every act to the accomplishment of what you are going to undertake. If you will but make up your mind to go through with what you undertake, you will do that which will bring you more genuine pleasure, satisfaction and comfort in life than anything else you will ever do.

THE GROWTH OF RESEARCH IN AN INDUSTRY

(*Continued from page 278*)

rections necessary, in the use of the spectrophotometer, to take care of errors due to lack of purity in the spectrum, and a new form of variable rotating sectored disk was developed which has since been found very satisfactory.

As is generally the case in research work, certain investigations suggested others, and the methods developed in the former were found useful in the latter. Thus the method used in the study of the conduction losses in an incandescent filament was employed to study the variation from Lambert's cosine law of emission found in tungsten filaments, and the Thomson electro-motive force in metals at high temperatures. At the same time the physiologist was studying the influence of illumination of the eye on visual acuity, and coöperating with one of the physicists on the dependence of visual acuity on the wave-lengths of light, and with the psychologist on the effect on acuity of the visual field.

As the laboratory grew it was found that there was a big opportunity for work in the practical problems of illumination, and this led ultimately to the establishment of a section called the "applied science" section in contrast to that of the pure science. In this section were taken up those problems connected with the utilization of light, such as glare, reflection from walls and ceilings, reproduction of daylight quality in an artificial light source, etc.

During the war the entire resources of the laboratory were tendered to the government, and while the staff was depleted by the entrance of the physiologist and psychologist into the service, considerable work was done on the testing and development of small lamps for signal work, on the relative advantages of binocular and monocular vision for field glasses, and on camouflage as used by both the army and navy.

The question of temperature is so inextricably wrapped up in the whole subject of radiation that a great deal of research work has been carried out in the laboratory to establish a high-temperature scale. As a result it is now possible to identify temperatures almost up to the melting point of tungsten, 3400°C, and much has been learned about the errors to be looked out for in optical pyrometry.

At the present time work is being done on the broad problem of the physical properties of metals at high temperatures and on the radiating properties of various rare earth oxides in the same temperature region. A division of biology has been added in which the effect of light on living organisms will be studied with the expectation of ultimately learning more of its effect on human life. Another problem under investigation is the effect of various intensities of illumination on visual acuity and the speed of vision.

The previous discussion has been confined to a consideration of research in pure science, but the term research has a much broader scope, and as indicated in the first paragraph, any study for the purpose of discovering new facts or developing new methods, processes or improvements properly comes under this head. In recognition of this fact the company has established a research department whose purpose is the correlation of all classes of research, so that it may be carried on with a minimum of duplication, a maximum of efficiency and as complete coöperation as possible.

A very important part of research work is the dissemination of the results, and all investigations, except certain of those carried out in the applied science laboratory, have been published either in the scientific or technical press. In addition, in order to collect material and make it available in condensed form, the laboratories have published a Bulletin containing abstracts of all papers published. Two numbers have already been issued, and a third is nearly ready for the press.

The results of research played such an important part in the late war, that its value was realized to an extent never before approached. As a consequence, not only has it received a great deal of attention in published articles and even in books, but many industries both here and abroad have established research departments, and it is to be hoped that in their cases, as in the case of what is now the National Lamp Works of the General Electric Company, it will be found that what at first may be considered a donation to science will soon be recognized as an investment.

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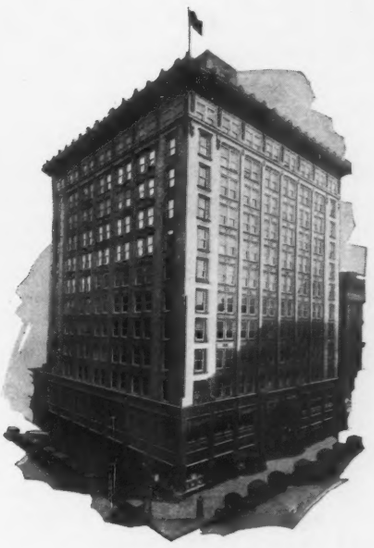

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A folder on the subject of the use of alternating current in high-speed passenger installations will be sent on request to Department T.

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THE MINING, GEOLOGICAL, AND METALLURGICAL LABORATORIES OF THE INSTITUTE

(*Continued from page 274*)

and experience as he would obtain from full-sized apparatus.

It is very unwise to undertake the installation of a large operating mill or smelting plant, especially in a single job of construction. Such a policy will lead to mistakes, leaving the school with a white elephant on its hands, and no room for anything else. It is far better to allow ample space for growth, make a modest start, and develop step by step, adding machines and apparatus as needed.

In all phases of his laboratory work the student should not lose sight of the fact that one very important aim in ore dressing and metallurgy is to develop his analytical mind, so that throughout the test he shall be gathering all the data necessary to enable him at the end to draw the proper conclusions as to just what has been demonstrated, or to calculate exactly what a machine has done from the viewpoint of efficiency or recovery. In other words, if he feeds a machine with some ore containing certain values, he should be able to report just what the machine has done in saving these values in its products, and where losses have taken place.

The student should clearly understand that laboratory instruction can never be the equivalent of practice, and that he will find much to learn in commercial plants. Time is usually a factor in the laboratory, and laboratory apparatus must be kept keyed up to a high pitch so as to run satisfactorily and under nearly perfect conditions. More elasticity for experiment is possible in the laboratory than in a commercial plant. In the latter there are all the daily breakdowns, repairs, replacements and difficulties resulting from constantly changing conditions, which keep the operator continually on the jump, and which present a new viewpoint to the man who has had experience only with a smooth-running laboratory experiment. Obviously it would be impossible to keep a class in the laboratory long enough to get this phase of the subject, and even if it were, the atmosphere of a student laboratory could never be equivalent to that of commercial work.

A little glimpse of the present quarters is afforded by the accompanying photograph of the mining building, which gives an interesting comparison with the laboratory of half a century ago, but a fuller appreciation of growth may be obtained from a detailed study of the original layout of the present buildings.

Mining Laboratory. Drilling and drill sharpening.

Crushing and Sampling Room. Breakers, rolls and various grinding machines, with shaking and vibrating screens and sampling devices.

Ore Dressing Laboratory. Treatment of ores by gravity concentration on screens, classifiers, jigs, tables and vanners; by magnetic separation; by oil flotation; by pan amalgamation; by stamp milling and amalgamation; all with the accessory equipment of tanks, water supply, driers, feeders, etc.

Fire Metallurgy. Blast furnace smelting for copper or lead ores; various roasting operations in reverbatory, revolving or multiple-hearth furnaces; copper refining by furnacing; zinc retorting; retorting of amalgam; cupellation of base bullion; sintering by Dwight Lloyd process; briquetting; copper converting; zinc desilverization; electrostatic fume precipitation by Cottrell process; sundry heating and melting operations performed in small gas and oil furnaces of various types; blast roasting.

Wet Metallurgy. Chlorination of gold ores; cyanide leaching; filtering by various devices; pebble mill grinding, leaching of copper ores, copper refining by electro-deposition, small electric furnace work.

Fire Assaying. Coked-fired crucible furnaces; muffle furnaces fired by coal, gas, gasoline and oil; agitation apparatus for small scale leaching; leaching of silver ores.

Weighing Room. Gold and silver balances and chemical balances for both fire and wet assaying.

Wet Assaying. Standard chemical equipment.

Metallography and Heat Treatment. Gas and electric furnaces; polishing apparatus; microscopes and photographing apparatus; dark room; testing machines.

Research Laboratories. Electrically and chemically equipped for advanced students and instructing staff.

Drafting Room. For work in plant design.

Department Shop. The usual small machines and tools for metal and wood work.

Economic Geology. Working collections of economic minerals illustrating ore occurrences; apparatus for mineralographic work on polished and thin sections of ores.

Petrographic Laboratory. Microscopes and good study collections of rocks and their sections.

Structural and Lithological Laboratory. A splendid collection of building stones and other specimens to show features of general geology and the effects of physical agents.

Palæontology. Collections of fossils for study and reference covering different ages and a wide range of locality.

Mineralogy. Equipment and collections for systematic determination of minerals.

Map Room. Containing valuable geological records.

Graduates' Room. For conferences and for collections of suites of rocks and minerals illustrating prominent economic districts.

Dark Room. For use in connection with mineralography.

Preparation Room. Sawing and polishing of specimens.

Research Laboratory. Electrically and chemically equipped for geological research.

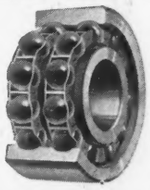
HYDRAULIC WAVE TRANSMISSION OF POWER

(*Continued from page 284*)

The drill is flushed by the stationary pipe d. The return stroke is not effected by a spring, but by connecting chamber e with the wave chamber, return motion being provided by the two different diameters of f and g. Motion of b towards the left compresses water in e which acts as a return spring. The rotary motion is effected by an internally toothed ring h, of which lug j engages with a double-ended plunger k. One end of this plunger is connected to the wave pressure, and the other to a chamber maintained under mean pressure. A reciprocating motion is thus set up which rotates the drill, feeding by hand in the usual way.

It may be said that the system is quite in its early stages, although its exponents have great hope for it being prepared to show that the system will perform seventy-five per cent more work than compressed air with twenty-five per cent less power under good average air conditions. Seeing that the apparatus is of a portable nature, and could take the place of a portable air plant, the saving should be even more marked, and it would appear to offer a suitable means of operating drills on quarrying and prospecting operations.

Single-row, deep-groove Conrad type, radial bearing.



Double-row, maximum type, radial bearing.

Single-row, maximum type, radial bearing.

Double-row, deep-groove Conrad type, radial bearing.

The STROM Ball Bearing Principle

Angular contact bearing —combination radial and thrust.

The highest stage in the development of friction-reducing bearings has been reached in the Ball Bearing.

In this type the rolling element—
a sphere—has the advantage of

A single dimension
Continuous working surface
Uniform working surface
Uniform shape
Uniform strength

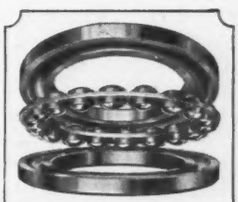
These advantages promote

Minimum rolling friction
Elimination of problem of aligning and adjusting rolling elements
Accuracy of manufacture
Perfection in finish
Simplicity of construction

All of which result in

Quietness and smoothness of operation
Reliability Durability
Economy Efficiency

Any ball bearing having the STROM imprint can be depended upon as incorporating all of the qualities which are essential in a high-grade bearing.



Single-acting thrust bearing with flat seats (grooved races). 1100-F Series.

Double-acting, self-aligning thrust bearing with leveling washers 2100-U Series.

Strom BEARINGS

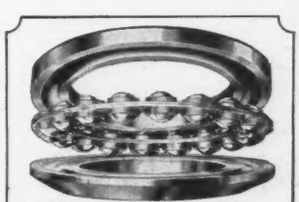
4556 PALMER STREET
CHICAGO, ILL.

(1966)

Double-acting thrust bearing, flat seats. 2100-F Series.

Double-acting, self-aligning thrust bearing 2100 Series

Single-acting, self-aligning thrust bearing, leveling washer. 1100-U Series.



Single-acting, self-aligning thrust bearing. 1100 Series.

THE ELECTRICAL ENGINEERING LABORATORIES OF TECHNOLOGY

(*Continued from page 277*)

into 230 volt, 3 phase, 60 cycle alternating current by means of a 187.5 kv-a. synchronous motor generator set; (3), into 230 volt, 3 phase, 24 cycle current by a 62.5 kv-a. generator, and (4), into 230 volt, 4 phase, 60 cycle current by means of a 62.5 kv-a. 3 phase generator and transformers. The generators mentioned in (3) and (4) are driven by a common synchronous motor.

The Measurements Division is located on the first floor of the main building, being directly adjacent to the balcony of the Dynamo Division. Power is delivered by feeders from the departmental substation. By means of throw-over switches these feeders may be connected to either the motor generator sets in the substation or to the power house supply. The main distributing panels in the laboratory are equipped with switches, fuses and circuit breakers. The following service is available for distribution from these panels. Direct current, 230-115 volts; direct current from storage battery 240-120 volts, alternating current, 3 phase, 60 cycle, 230 volts, 4 wire; 2 phase, 60 cycles 230-115 volts, 5-wire; and 3 phase 24 cycle, 230 volts, 3 wire. These main distributing panels are connected to 25 supply panels located at convenient points in the laboratory and adjacent rooms. Most of the panels are located along the walls of the laboratory, but four of them are mounted on standards and placed in the middle of the room for the purpose of supplying the tables used for meter testing and work of that nature. Taper plugs and flexible leads are used for making temporary connections, while connections that are of a semi-permanent nature may be made by clamping leads under cap screws and washers which are on all the panels.

There is a special low voltage high current storage battery, also a step-down transformer of high current capacity, so that it is possible to obtain a 2 volt storage battery current up to 850 amperes (at the three hour rate) and 5 volt alternating current up to 4000 amperes. The storage battery and the motor generating set for charging the same are located in a room adjacent to the laboratory. The motor generator set may be used to supply low voltage current to the laboratory, up to 150 amperes, and is used for many purposes where a particularly constant voltage is not necessary.

Another special feature of the power supply for this laboratory is a phase shifting motor generator set consisting of a direct current motor connected to two 3 phase alternators; voltage may be taken from one of these machines, and current from the other. It is possible, by means of a small motor provided with a remote control arrangement to shift the stator of one of these alternators with respect to that of the other, and thus obtain any desired power factor, either lagging or leading. The range of frequency is from 25 cycles to 60 cycles per second.

The equipment includes apparatus for making all of the usual electrical measurements with both direct and alternating current. There are numerous bridges, galvanometers condensers, vibration galvanometers, watt-hour meters and oscillographs and instruments of the portable type.

In order that the numerous portable instruments in use throughout the department may be calibrated without interfering with the class work in progress in the laboratory, a special room is set aside for the purpose, and is provided with standards of electromotive force and resistance, a potentiometer, and a number of secondary standard meters.

On account of the danger attending high-potential measurements, a separate room is provided for such work. Power is furnished by a specially designed 3 phase alternator driven by a direct current motor. There are two high-voltage transformers, one of 12 kv-a., giving 3 phase voltages up to 50,000, and a 15 kv-a. single-phase transformer giving voltages up to 100,000.

Investigations on 3 phase electric cables are being conducted in the laboratory, and a heating oven capable of taking a ten-foot sample is provided.

Measurements of puncturing voltages are made in a special booth which encloses the transformer and all the other high potential apparatus. Safety devices are provided, so that when any door of the booth is opened the voltage is automatically removed from the circuit.

Frequently it is necessary to immerse specimens which are to be subjected to puncturing voltages. For this purpose an iron tank is set beneath the floor. It is supplied with water and steam, and by a convenient arrangement of the valves the temperature may be regulated.

The Dynamo Division of the laboratory occupies a considerable portion of the basement floor, and balcony at first-floor level in the central building of the educational group. On the lower floor are placed the larger machines, while the smaller machines and transformers are placed in the balcony which surrounds the well of a ten-ton crane. The machines on the basement floor vary from five to seventy-five horse power. They include shunt, compound and interpole motors for brake tests and for driving other machines. A few of the driving motors are belted, but in order to save space many sets are direct connected, being mounted upon substantial channel bar frames provided with castors and jack screws, so that their location may be readily changed. A number of compound generators are placed at the

(*Continued on page 294*)

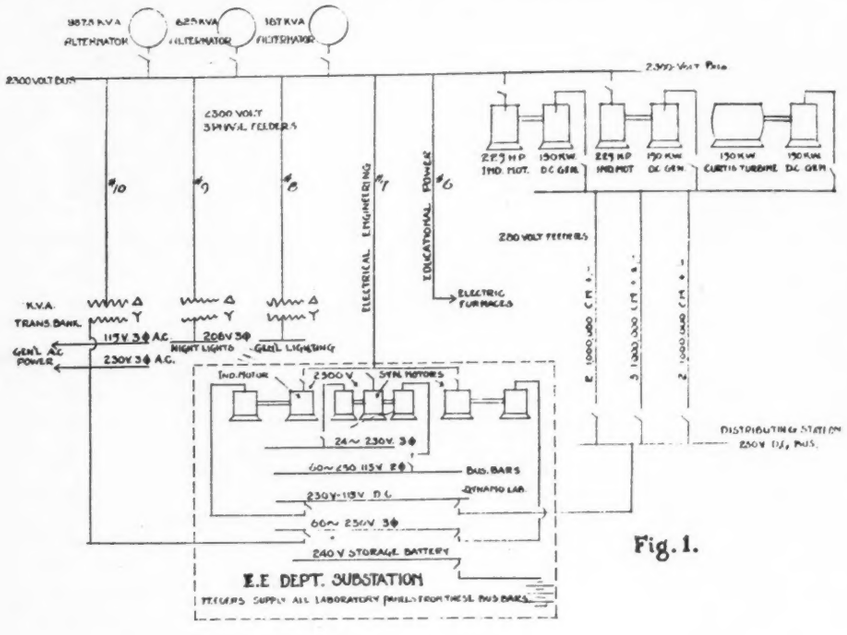


Fig. 1.

MEASURING UP TO A FAMOUS NAME

BACK of the name "Wright" lies the nineteen-year-old tradition to bring to the advancement of flying only the highest engineering principles and experience.

Accurately measuring the several phases of progress through which aviation has passed are the milestones of Wright Achievement covering the period of these nineteen years.

Only with a production organization capable of interpreting this wide engineering experience in terms of quality product could this company feel that it truly represented the impulse and high ideals of its founders.

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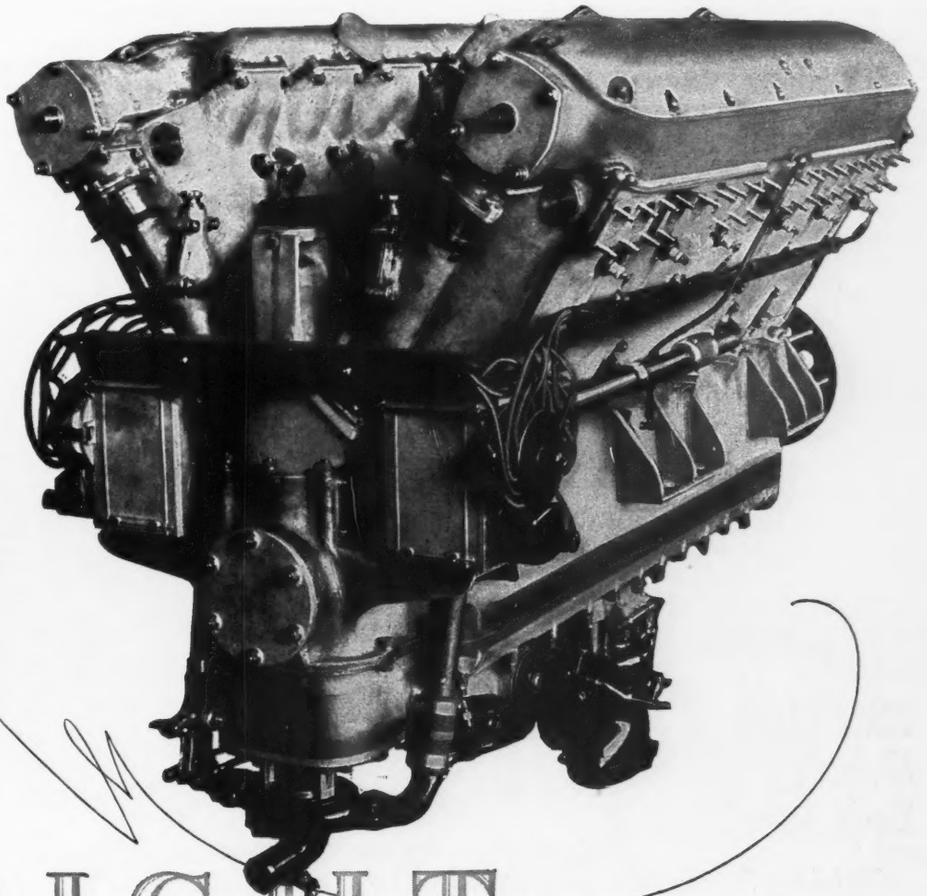


"The Identification of Incomparable Service"

WRIGHT

THE ELECTRICAL ENGINEERING LABORATORIES OF TECHNOLOGY

(*Continued from page 292*)

north end of the crane well, while at the south end of the well there are eight alternators available for efficiency and regulation tests, and for parallel operation, as well as for use as synchronous motors. The induction motors and synchronous converters are placed at the west end of the laboratory. In addition to the common types of equipment the laboratory possesses an alternating-current series motor, a 3-phase commutator motor which has series characteristics, and a phase advancer for improving the power factor on wound rotor induction motors. The smaller machines of the shunt, series and compound types are located in the balcony surrounding the crane well. Each machine is placed on a table which has a circuit-breaker protection as well as provisions for switching and measuring voltages and currents. Distribution panels are located between the tables so that connection to the laboratory feeders is convenient. Water is available at various points in the balcony for the cooling of the brake drums. The power transformers used for laboratory purposes are ranged along the walls. They are tested for losses and heating as well as for connections on polyphase circuits. There are also several constant current transformers and arc rectifiers such as are used for street lighting. The offices of the laboratory instructing staff are ranged around the balcony and the basement so that they are conveniently located to the laboratory.

Distributing centers are placed at convenient points in the laboratory, the arrangement being similar to that referred to in connection with the Measurements Division.

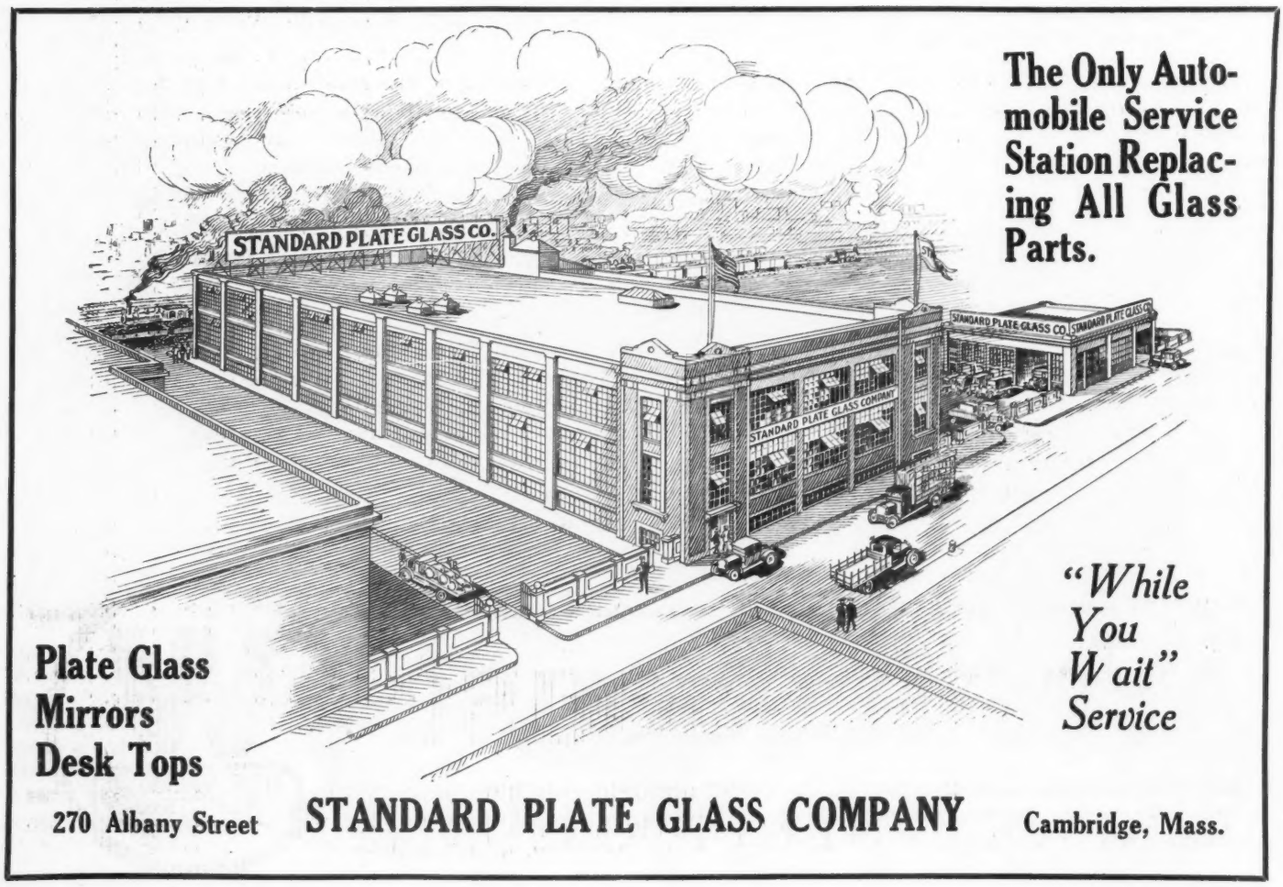
The problem of supplying instruments to a great number of students and adequately keeping them in order is a task of considerable magnitude. Over five hundred portable instruments are required for use in the Dynamo Division. They are kept in an instrument room and the services of an attendant are required from nine to six daily that they may be properly issued.

The Research Division Laboratory on the third floor of the main building is devoted to the solution of special problems, particularly by graduate students and by research assistants especially engaged for that class of work. The development of the Research Division of the Electrical Engineering Department has been due to the earnest interest of Professor D. C. Jackson, who early in his connection with the Institute placed great stress on this class of work as being of immense value in vivifying the instructing staff and the undergraduate students as well as those engaged in actual researches.

The primary aim of this laboratory is educational, the training of researchers, but the problems set are those derived from engineering practice. This laboratory provides a most valuable point of contact with the engineering world and realizes one of the most ardent hopes of Professor Holman who, writing in 1900, expressed himself as follows:

"The laboratory of the technical college must clearly be in direct relation with the technical part of the community through its investigations as well as through its graduates. The staff and methods of the laboratory must be in the closest possible touch with the best professional practice, but in all that concerns educational influence, the laboratory must lead. In that knowledge which arises from the practice of processes and the application of machines on the industrial

(*Continued on page 296*)



Engineering Levels Mountains

The Pack Train has become a relic of the past, along with the Prairie Schooner. Modern methods of transportation have leveled mountains, brought San Francisco nearer to New York, and widened the markets of all our great industries.

And the engineering brains and energy, that have developed transportation to the prominence it holds in the business of the world today, are no longer employed in improving means of overland travel alone. Street Railways, Elevator Systems, Interurban Lines and Improved Shipping Lines—these are some of the accomplishments of engineering in the development of better transportation.

Neither have the builders of such systems been concerned only in the actual hauling of people and materials. A study of the methods of handling passengers and freight at the large terminals has developed the Terminal Engineer, who has greatly improved existing methods, and has developed entirely new ones, as well.

Engineering, as it is applied to transportation, has had to concern itself with many kinds of materials and many ways of handling them under all manner of circumstances. For instance the problems surrounding the handling of iron ore, in bulk, are vastly different from those encountered in moving any one of the finished products manufactured from iron ore, that must also be transported in large quantities. But Engineering constantly meets each situation with improved transportation facilities.

Industry, as a whole, and the nations and the people of the world owe much to the engineers, associated with such large manufacturing industries as Westinghouse. They have not only brought about vast improvements, but they have done so at a constantly decreasing cost to those who derive the greatest benefit from them.

Westinghouse

ACHIEVEMENT & OPPORTUNITY

W

WESTINGHOUSE ELECTRIC

THE ELECTRICAL ENGINEERING LABORATORIES OF TECHNOLOGY

(*Continued from page 294*)

scale and for pecuniary ends, the laboratory will continually have much to learn from the professions. In all which concerns the development of principles and scientific advance in methods, the laboratory should be the leader."

The equipment of the Research Division Laboratory is such that all the ordinary electrical measurements may be executed with ease. There is also a considerable amount of special apparatus which has been developed in connection with the various researches — often an instrument which is a by-product of some research is of great value for its own sake.

The nature of some of the problems attacked is briefly indicated by the following. An investigation of paper-insulated cables, undertaken at the request of the Paper Insulated Cable Research Committee of the National Electric Light Association, is now in progress. The M. I. T. paper tester developed in connection with this research is a distinct advance upon the instruments hitherto employed for this purpose. Meetings of the above mentioned committee and representatives of the cable manufacturers are held at the Institute to discuss methods and results.

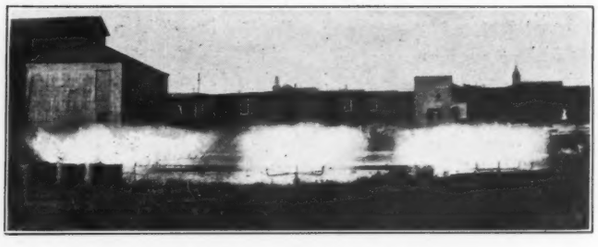
Transmission lines and their artificial equivalent have been extensively investigated, and a method of design for a replica line with distributed constants has been developed. Such an artificial line allows transient phenomena to be investigated in the laboratory. It is hoped that it will finally be possible to develop a method for constructing a model of a transmission system, so that various switching and other phenomena may be experimentally investigated.

Investigations of direct current transients and the distribution of transformer harmonics have been made by representatives of the division laboratory on an actual line placed at the disposal of the Research Division by the Alabama Power Company.

The problem of telephone interference has received much study, and the results of certain phases of the work have been incorporated in the report on Inductive Interference of the National Electric Light Association.

The last laboratory to be established is that of Electrical Communications, which is now being equipped with the special apparatus necessary for instruction in this sort of work. At present the equipment is complete enough to allow all of the experiments to be performed. The various necessary appliances required for the more convenient handling of the circuits are now being developed and installed.

Synthetic Cast Iron. The problem of determining the best conditions for the production of cast iron by melting scrap steel in the electric furnace has been solved by recent experiments with laboratory furnace. This condition as determined was applied with excellent results. Low grade miscellaneous steel scrap was melted and carburized in a three thousand pound direct arc, three-phase electric furnace and the resultant metal discharged into the molds for the miscellaneous gray iron castings. The carbon and silicon content of the product was under control at all times and the furnace operator had no difficulty in producing the grade of iron required. Satisfactory castings were made with the normal consumption of power and electrodes.



The Above Illustration Shows the

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In connection with the Municipal Power Plant of the City of Dothan, Alabama, capacity 3,000 gallons per minute. Note the uniform spray, even distribution and clear air passages. The Superintendent reports that when carrying full load in the hottest days of summer they never obtain less than 27 inches vacuum. In November last they were running with 29.6 inches vacuum. They changed from the old spray system to the new "SPRACO" inside of forty-eight hours.

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These miners of the Stone Age first built fires to disintegrate the harder rocks, then they pounded out their treasures. Hammers of diorite or porphyry, shaped by the waters of the lake or by hand, occasionally grooved and fitted with a handle; wedges made of the very substance they were mining and tempered by the pounding that fashioned them; shovels of cedar that were used only as scrapers; bailers of bark or carved wood —these were the tools used in their open pit mines.

Now, whole mountains are removed to obtain copper; 47,000 tons of copper ore have been mined in a single day at one mine with the aid of Hercules Explosives. The principal problem of today is not the mining of the metals, it is the elimination of waste in their production.

We have for years recommended Hercules Special No. 1 because of its higher cartridge count and lower cost per cartridge in comparison with the dynamites in general use. No high explosive on the market is more economical.

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PAPER DE-INKING

(*Continued from page 273*)

Bentonite is defined by the United States Geological Survey as a transported, stratified, volcanic ash that has been altered shortly after deposition. It is very fine grained, and has the property of swelling in contact with water to several times its original volume into a jelly-like mass which, on further dilution, forms colloidal solutions which will remain in suspension indefinitely in mixtures as dilute as one part of bentonite to fifty parts of water. Like any natural product, different deposits differ considerably, and the finest grained or most colloidal that have been found occur in Wyoming, although samples from many deposits in that State proved to be low in colloidal content. Samples freshly taken from the quarries are of a greenish yellow color, but on exposure to the air become light cream. Numerous chemical analyses have been reported and considerable variation exists in samples from various sources. It is a mineral akin to kaolin, although generally yielding, on analysis, more silica, less alumina, and more magnesia. It has been found to be an excellent filler for paper. It is its physical properties, however, that render it of most value in de-inking paper, and of these fineness is of most importance.

In de-inking printed paper and especially newspaper, it is comparatively easy to loosen the carbon black by dissolving the varnish of the printing ink by means of alkalies such as sodium carbonate or caustic soda, using as little as forty pounds of sodium carbonate per ton of paper, and temperatures as low as one hundred and twenty degrees Fahrenheit. Such treatment will not injure groundwood pulp, and, if the carbon black could be completely washed out after liberation, a satisfactory material would be obtained. Unfortunately the fibres of the paper stock serve as a very effective filter in immeshing the particles of carbon, and there are no means of washing in common use that will permit their complete removal without excessive losses of pulp or expenditures of time, power and water that are prohibitive. In fact a point seems to be reached beyond which it is impossible to remove the remaining traces of ink. The problem is entirely different from the removal of soluble impurities such as cooking liquor or bleach residues, and very successful methods for handling the latter impurities will not answer the purpose. With bentonite, however, we have a substance that will pass through ordinary filters and, with its enormous surface, on account of the extreme fineness of its particles, will carry the carbon black along with it. Even when washing with bentonite, however, it is better to avoid the formation of a sheet of felted fibres against the wire surface which will form a good filtering medium, and drum washers are consequently better than decker washers.

Tests of the process were made both in the Forest Products Laboratory of the University of Wisconsin and in the plant of the Watab Paper Company of Minnesota. The laboratory runs seemed to indicate that either used news, book or bond paper could be satisfactorily washed with the help of bentonite and used in making the same type of paper. Yield determinations on several runs indicated an average loss from nine to ten per cent. The average time for washing the news runs was one hour. Measurements on the water used indicated a rate of 3.5 gallons per minute during the washing period.

(*Continued on page 300*)

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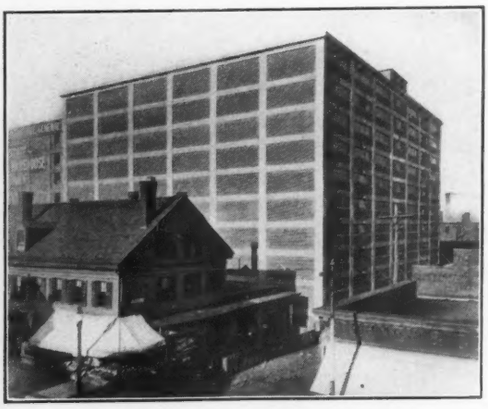

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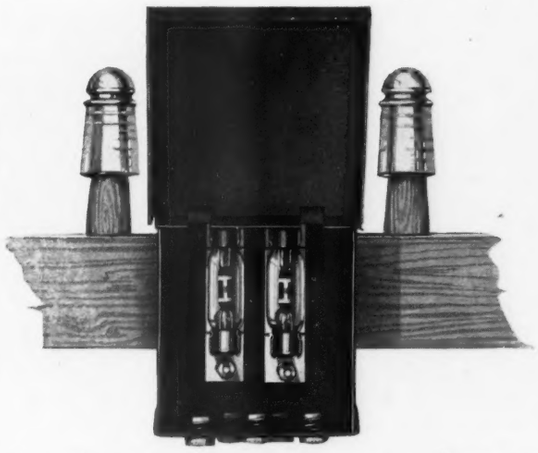

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for the protection of low voltage circuits because with them they can have uninterrupted service; intact equipment; positive protection against static; lightning; crosses; and grounds.

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Atlas Ammite Explosive *will not cause headaches* from handling. Think what this means to blasters who have endured for years the sickening headaches caused by certain kinds of dynamite.

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This new and larger list includes scores of sizes heretofore unobtainable except as made-to-order.

The addition of these new sizes more than doubles the opportunity of the machinery builder and user to save time and money by specifying and using Bunting "Ready Made" bushing bearings.

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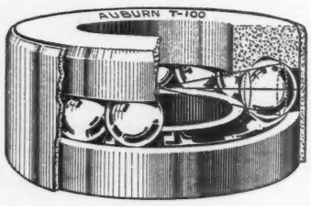
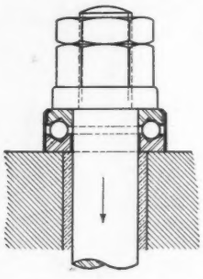


AUBURN BALL THRUST BEARINGS

answer many thrust problems



Write for copy of "Ball Bearing Engineering"

AUBURN BALL BEARING CO.

44 Elizabeth Street

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Trade Mark

THE DE-INKING OF OLD NEWSPAPERS

(Continued from page 298)

At the Watab Paper Company the test was carried out in a regular mill building, and the practicability of the process could be determined. It was first attempted to obtain an output of forty tons of de-inked pulp per day. It was found, however, that the color of the stock was too dull for the grades of paper being made, and the output was reduced to thirty tons per day, to give more time in the washers. A new type of washer was also perfected for this particular kind of work. During the trial run something over fifteen hundred tons of old newspaper stock was de-inked, using bentonite as the carrying agent. Slight changes were made from time to time, and the proportions of chemicals finally used were as follows:

Old Newspaper Stock	2500 lbs.
Bentonite	200 "
Soda Ash	40 "
Hydrated Lime	25 "

The possibilities of a process for the recovery of old newspaper stock as has been described are apparent to any one familiar with the paper industry. When the price paid for old paper stimulated collection, it is reported that about twenty-five thousand tons per month were collected in Chicago, of which forty per cent was news. During the same period Cleveland is reported to have handled approximately three hundred and fifty tons per day, of which one hundred and fifty tons was news. The source is furthermore at the place of consumption, and the saving in freight is a very important item. The color requirements of the publishers at the present time are very severe, and any process that does not thoroughly remove the ink cannot be successful. While considerable difficulty was encountered in meeting these requirements in the trials herein described, the results obtained as the process has been finally worked out seem to justify our belief that they can be met. The application of the de-inking process will not materially benefit existing mills, which are in most cases located near their original source of raw material in somewhat isolated and small communities. However, from a raw material viewpoint, especially in its forest depletion phase, the wide application of de-inking of old newspapers has potentially a very important bearing on the forestry problem in America today.

Open Side Filter Rings

The convenient open side allows removal of apparatus without taking apart.

Prevents spilling and loss of liquids.

Inner edge beveled.

Specify *Knott Open Side Filter Rings* for your Laboratory Equipment

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Scientific Instrument Makers

Cambridge, Mass.

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THE MURRAY PRINTING COMPANY is located at Kendall Square, Cambridge, in its own modern and commodious building, with a plant that is efficient in every detail. The firm has been established one-quarter of a century and handles the printing of catalogues, periodicals and technical books. The firm's list of customers includes many large manufacturers and publishing houses of New England.

Always ready to intelligently coöperate with you on your printing requirements

THE MURRAY PRINTING COMPANY

KENDALL SQUARE, CAMBRIDGE

KREOLITE

Is Your Floor Problem Like *This* One?

THERE are hundreds, if not thousands of companies with the same difficulties you have. There is no need to waste your time and money experimenting.

Send for the Kreolite Factory Floor Engineer. At his command is the most comprehensive data on floors for all purposes. He will study your needs and show you how to permanently solve your floor problems, based on the history of similar cases, without cost and obligation to you.

For example: A Detroit automobile company was building a new factory. One building presented a serious floor problem. Our factory floor engineer was sent for. He was told that large heat-treating furnaces would be in this building, and that heavy trucking would be done continually. Large castings would be handled with liability of their dropping upon the floor. Workmen would stand upon the floor continually in three shifts.

That was five years ago. Today the Kreolite Wood Floor in this factory is practically as good as new. It has met all the needs and has proven most economical. There are no ruts as a result of the heavy trucking. Connecting rods at white heat have been dropped from the furnaces onto the floor with perfect immunity from danger of fire. (This test was made to convince the Fire Chief.) Large castings have been dropped on the floor ***without breaking*** and the superintendent and workmen alike testify that it is more comfortable to stand upon.

Different kinds of business present distinct and peculiar floor requirements. Save money and trouble by writing us for floor information pertaining to your SPECIAL industry.

Redwood Block Floors

Write us for details regarding our Kreolite Redwood Block Floors

The Jennison-Wright Company
86 Kreolite Building, Toledo, Ohio
Branches in All Large Cities

Outlast the Factory

WOOD BLOCK FLOORS

STATIC ELECTRICITY

(*Continued from page 279*)

velocity greater than twenty-six feet per second. The water breaks up into spray, and this upward draft of air carries the small drops up to the high altitudes and the large drops not so high. When the water falls as rain, the large drops and the heavy downpour are almost invariably positively charged, and the fine rain which comes afterwards is almost always negatively charged. This would indicate that the small drops which were carried up higher contained negative charges.

It seems plausible that when tank trucks carrying supplies of gasoline are driven over the roads the splashing of the gasoline on the inside of the tank probably breaks the gasoline up into a spray, and very likely the spray striking the sides charges the tank. At any rate, there is strong evidence that the tanks are very often charged with electricity, and you will find it quite common practice for tank wagons to drag a chain along the road, attached to the tank, the reason being to keep the tank discharged.

A case comes to mind which happened a year ago. The tank wagon had three compartments. It traveled twenty-seven miles and started to empty the gasoline. It had emptied one compartment completely and was emptying the other compartments, using a Ford inner tube to conduct the gasoline from the tank into the underground tank, and when the tanks were partly unloaded a fire suddenly took place, apparently from nowhere. The tank blew up, the garage was burned, as were several adjoining buildings, resulting in a very serious accident, and nobody knew what caused it. It might have been static electricity — we do not know; it might have been a lighted cigarette.

During one season in the far Northwest, threshing machines were exploding, literally dozens a day, several hundred during the season. The humidity conditions were exceptional — that is, very low, running down to eight and ten per cent. It was found that immense quantities of static electricity were developed in the threshing machines, and the drier the dust (largely smut), in the wheat, the more static electricity was generated. This smut dust was very inflammable, and could be easily ignited by a static spark simply by rubbing the dust off a spatula onto the terminals of a static electrical generating machine, between which discharge sparks were passing. The dust would be ignited and the flame would flash through the suspended dust around the terminals.

These fires and explosions seldom occurred in threshing machines except on days of extremely low humidity. They did not often occur in the morning, and they did not often occur in the evening, when temperatures were down, but happened very largely between ten in the morning and two or three in the afternoon.

The same thing is true in the cotton gins in the South. The ginners, in many cases, discovered that a cure for fires was to keep the gin wet down, and this became the usual practice in many gins during the dry weather. They simply created a higher humidity in the atmosphere and the static which was generated was dispersed into the air. Cotton is very easily ignited by a static discharge, but one of the peculiar things about it is that it is more easily ignited when it is near the negatively charged body.

Cotton moving through pipes will become charged positively, while the pipe through which cotton is blown will become charged negatively. If the cotton then is blown against a screen, so that the air will pass through and the cotton drop down, as is the condition in a cotton gin, the charge in the cotton is dissipated upon the screen. If the screen and pipe are electrically connected, only a slight negative charge is noticeable on the pipe, as the charge on the screen and pipe would be nearly equal before being connected,

(*Continued on page 304*)

GENERAL WELDING & EQUIPMENT CO.
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WELDING AND CUTTING EQUIPMENTS
AUTOMATIC CUTTING MACHINES

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THE DISADVANTAGE OF POOR LIGHTING.

As thousands of our industrial plants are operating to-day with poor lighting and in some cases with extremely bad facilities, it would seem that the importance of the subject of lighting has not been given the serious consideration by those responsible for such conditions.

Poor lighting is one of the most serious handicaps under which a manufacturing establishment can operate. First of all, poor lighting is the cause of a large number of accidents in industrial plants; and it is singular that accident reports do not yet properly classify the hazards of poor lighting, which in many cases is the primary cause of an accident attributed to what is really a secondary cause. Safety engineers and other officials who make accident reports should always consider the condition of the lighting when working up a report of accident causes, for it plays an important part in a great many casualties and is apt to be overlooked. All accidents due to poor lighting are accidents of neglect, and are preventable. The poor lighting accident hazard is clearly chargeable to management and not men. It is a difficult matter to make such progress with Safety First in a plant which has neglected to provide one of the fundamental requirements of accident prevention—good lighting.

Probably no one single factor connected with the equipment of a plant so directly affects the efficiency and inefficiency as the quality and quantity of the lighting. The curtailment of production of all working under the disadvantage of poor lighting represents a big loss each day; the poorer the lighting the less able is the working force to function efficiently. Quality and quantity both suffer, representing a preventable loss wholly removable by improving the lighting.

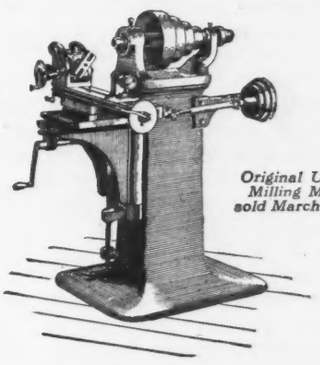
Under poor lighting condition, we cannot expect and rarely do we find an orderly, clean factory. Darkened places encourage careless habits and workers are often led to deposit discarded articles or material which should be deposited elsewhere. The eyesight of those who attempt to use their eyes continually in insufficient light, below nature's demands, is often affected. Too much light, such as is furnished by bright, unprotected lights, is as harmful as too little illumination; both are fundamentally wrong. Nature's own illuminant, daylight, is unequalled for our requirements of lighting.

The eye is best suited to daylight in the proper quantity. Sun glare should be avoided, and in the darkened hours proper artificial illumination provided. Daylight should be utilized to the fullest extent. It is supplied free in abundant quantity for our use. Modern invention has supplied a means whereby the interior of buildings can be lighted by daylight, and all the advantages secured which is furnished by good lighting at the smallest cost.

Industrial buildings should have as much wall space as possible devoted to windows fitted with Factrolite Glass, which insures the maximum amount of daylight and which prevents the direct rays of the sun from passing through as it properly diffuses the light.

If you are interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

MISSISSIPPI WIRE GLASS CO.,
220 Fifth Avenue,
St. Louis. New York. Chicago.



Original Universal Milling Machine sold March 14, 1862

An Important Invention

The Universal Milling Machine was one of the most important machine-tool inventions which sprang from the necessities of the Civil War.

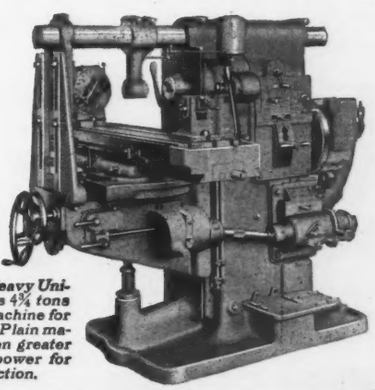
At that time, the manufacture of percussion nipples required large numbers of twist drills made by the best method then known—filing spiral grooves in steel wire with a rat-tail file.

Hand-filing was so expensive that Mr. Joseph R. Brown, of J. R. Brown & Sharpe, was consulted as to the possibility of a machine for grooving these drills.

The result was the Universal Milling Machine, suitable for many kinds of spiral milling, gear cutting and other work previously done by hand.

From this beginning the Brown & Sharpe line has grown to include over 30 sizes of milling machines—Universal, Plain, Vertical Spindle and Automatic. A large number of these are heavy machines particularly suited to production work.

BROWN & SHARPE MFG. CO.
Providence, R. I., U.S.A.



Our No. 4 A Heavy Universal weighs 4¾ tons —a rugged machine for heavy work. Plain machines of even greater weight and power for heavy production.

STATIC ELECTRICITY

(*Continued from page 302*)

and so would neutralize each other.

One of the first principles which should be considered is the types of discharges that are generated, the different materials, and where those charges may be given up. Is there a possibility of connecting up the positive and the negative sources to prevent the jumping of the spark or the accumulation of the discharge? That is one thing which was done in the cotton gins and in the threshing machines — also carrying the connecting wires to the ground and being sure that the ground was absolute and complete.

Dr. Rudge of England, working in Africa, has found that dust particles moving through the air create charges, and even has gone so far as to state that it is conceivably possible that a coal-dust cloud — he was particularly dealing with coal dust at the time — moving through the air might create such a charge upon itself that, coming in contact with the ground, it might discharge with such an intense spark as to ignite the dust and start an explosion. This seems to be conceivable. The case is analogous to that of a thunderstorm. In one you have the discharge from an accumulated static in the atmosphere on the particles of moisture, in the other you have it on the particles of dust.

There are three ways of getting rid of the hazard of static electricity. One is by humidifying so that the static may be dissipated into the air as fast as it is generated. This cannot be used in the flour industry, because you cannot operate under excessive humid conditions without getting a sticky product. With cotton gins and in other industries you can.

Another method is grounding. This is the simplest method and will work quite well in many conditions, if you are sure that you have a ground; but to be sure that you have a ground you must have more than one connection, preferably three.

The third method is to neutralize the charge as it may be developed by means of counter charges, or by the use of what is called a neutralizer. There is one on the market which has been found to be quite successful and is used largely in the printing and paper industries and in some others. An ordinary 110 volt current is used. Its voltage is tremendously increased with a corresponding decrease in amperage, really making current from it which is similar to a static current. This is dissipated through points into the atmosphere, so that the atmosphere is electrified first positively and then negatively. If a positive charge is being developed in the moving of the material, then the negative charge given off by this neutralizer will neutralize the positive and *vice versa*. These three methods are now in vogue. All have their direct application.

Static electricity is a hazard. Static electricity will ignite dust, will ignite gases, will ignite solid materials, and it is a thing that must be considered more seriously in the future in connection with the possible causes of fires and destruction of property.

Experiments on Kerosenes. According to a report by Dr. J. H. James, head of the research laboratories of Carnegie Institute of Technology who is conducting experiments to determine the relative efficiency of kerosenes and oxidized kerosenes as fuels, oxidized kerosenes cause less "knocking" tendencies than straight kerosene when used in kerosene engines. The tests also showed that oxidized kerosenes have approximately the same power development as ordinary kerosene, in spite of the fact that their thermal value is one-eighth less. The efficiency of oxidized kerosenes is attributed to better "clean up" in the combustion of these partially oxidized fuels. The success of the experimental work at this stage gives promise that oxidized kerosene, which is manufactured by catalytic oxidation of low grade petroleum may become a useful fuel in the future.

Award of Edison Medal of 1922. The Edison Medal for the year 1922 has been awarded by the Edison Medal Committee of the American Institute of Electrical Engineers to Dr. Robert A. Millikan of Pasadena, California "for his experimental work."

STARKWEATHER & BROADHURST, Inc.

Engineers and Contractors
for
Power Plant Apparatus

TELEPHONE CONGRESS 1810 **79 MILK STREET, BOSTON**

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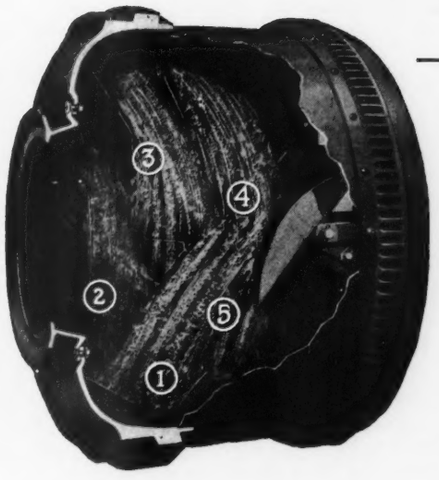
Made of extra quality cotton yarn, carefully inspected and guaranteed free from all imperfections of braid or finish. The colored spots are our trade-mark, used only with this quality.
We make braided cord of all sizes, kinds and colors, for all purposes, including sash cord, clothes lines, trolley cord, signal cord, arc lamp cord, and many special cords for special purposes.

CATALOGUE AND SAMPLES GLADLY SENT ON REQUEST

SAMSON CORDAGE WORKS **88 Broad Street, Boston 9, Mass.**

Test the Materials and then-



(1) Blade cuts through materials with churning action. (2) Blade carries materials up, spilling down again against motion of drum. (3) Materials hurled across diameter of drum. (4) Materials elevated to drum top and cascaded down to reversed discharge chute which (5) with scattering, spraying action, showers materials back to charging side for repeated trips through mixing process.

—remember that it depends on the mixer to combine the raw materials, aggregate cement and water into concrete that actually possesses the latent strength of the materials.

That is why Koehring-mixed concrete is Dominant Strength Concrete—because the five action remixing principle prevents separation of aggregates according to size, coats every particle of aggregate thoroughly with cement, and delivers uniform concrete to the last shovelful of every batch.

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To be admitted to the first year class, applicants must have attained the age of seventeen years, and must satisfactorily fulfill entrance requirements in Algebra, Plane and Solid Geometry, Trigonometry, Physics, Chemistry, English, History, and French or German and one elective subject. Examinations are required in all subjects except Chemistry, History and the elective, the requirements for which are fulfilled by the presentation of satisfactory certificates. A division of these entrance subjects between different examination periods is permitted.

Entrance examinations are held at the Institute in September. In June, applicants will be examined by the College Entrance Examination Board in Boston, New York, Philadelphia, Chicago, and many other cities in America and Europe. A circular stating times and places is issued in advance by the College Board.

Graduates of colleges and scientific schools of collegiate grade, and in general all applicants presenting satisfactory certificates showing work done at another college corresponding to at least one year's work at the Institute, are admitted, without examination, to such advanced standing as is warranted by their previous training.

Graduate courses leading to the degrees of Master of Science, Master in Architecture, Doctor of Philosophy and Doctor of Science are also offered. Special Research Laboratories of Physical Chemistry, Applied Chemistry and Science have been established.

PUBLICATIONS

Bulletins of General Information, Courses of Study, Summer Session, Advanced Study and Research; and the Report of the President and the Treasurer.

Any of the above-named publications will be mailed free on application.

For information, address

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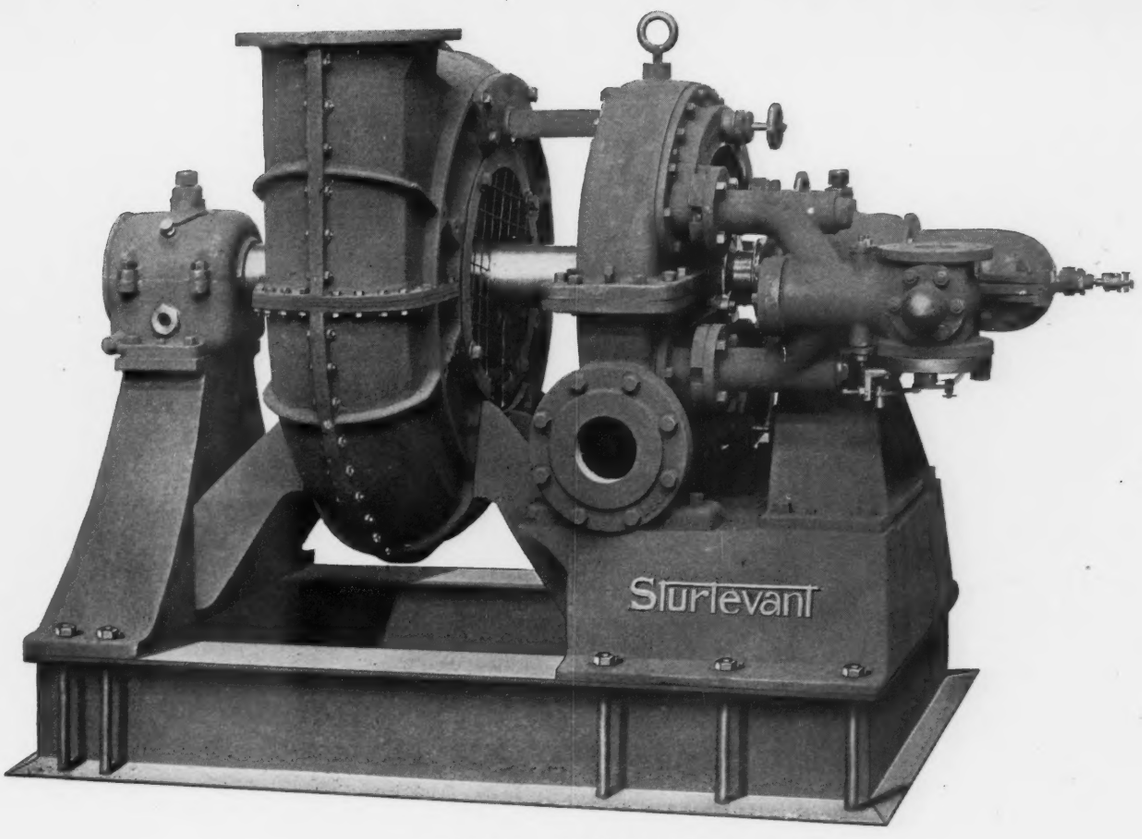

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The New Turboblower Is Simplicity Itself

This turboblower is a gas blower and steam turbine combined in one unit.

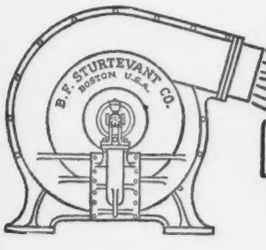
There are only two bearings; these are self-aligning and ring oiling; no couplings to line up or adjust.

Both the blower and the turbine have split casings, making for easy access to rotating parts.

Special turbine packings insure months of operation without adjusting stuffing boxes. Both speed and emergency governors are provided. Air pressures up to forty and even fifty inches, and volumes up to and above thirty thousand cubic feet of air per minute can be supplied.

This new turboblower is the simplest and most dependable apparatus yet designed for blowing water gas sets.

Send for more detailed information.



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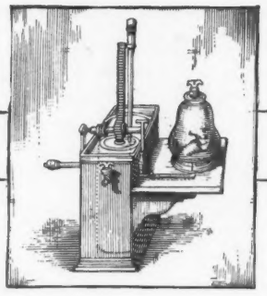

AIR ~ PUMP

The *"PRACTICAL"* Alchemist *and* *"THEORETICAL"* Robert Boyle

THE alchemists wrote vaguely of "fluids" and "principles." Copper was potentially silver. Rid it of its red color and the "principle" of silver would assert itself, so that silver would remain. With a certain amount of philosopher's stone (itself a mysterious "principle") a base metal could be converted into a quantity of gold a million times as great.

This all sounded so "practical" that Kings listened credulously, but the only tangible result was that they were enriched with much bogus gold.

Scientific theorists like Robert Boyle (1627-1691) proved more "practical" by testing matter, discovering its composition and then drawing scientific conclusions that could thereafter be usefully and honestly applied. Alchemists conjectured and died; he experimented and lived.

Using the air pump Boyle undertook a "theoretical" but scientific experimental study of the atmosphere and discovered that it had a "spring" in it, or in other words that it could expand. He also established the connection between the boiling point of water and atmospheric pressure, a very "theoretical" discovery in his day but one which every steam engineer now applies.

He was the first to use the term "analysis" in the modern chemical sense, the first to define an element as a body which cannot be subdivided and from which compounds can be reconstituted.

Boyle's work has not ended. Today in the Research Laboratories of the General Electric Company it is being continued. Much light has there been shed on the chemical reactions that occur in a vessel in which a nearly perfect vacuum has been produced. One practical result of this work is the vacuum tube which plays an essential part in radio work and roentgenology.

General Electric Company

General Office *Schenectady, N.Y.*

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